EXHIBIT C

US006243446B1

(12) **United States Patent**
Goodman

(10) Patent No.: **US 6,243,446 B1**
(45) Date of Patent: ***Jun. 5, 2001**

(54) **DISTRIBUTED SPLITTER FOR DATA TRANSMISSION OVER TWISTED WIRE PAIRS**

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(73) Assignees: **Inline Connections Corporation**, Arlington, VA (US); **CAIS, Inc.**, Washington, DC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **09/362,180**

(22) Filed: **Jul. 27, 1999**

Related U.S. Application Data

(63) Continuation of application No. 08/814,837, filed on Mar. 11, 1997, now Pat. No. 5,844,596.

(51) **Int. Cl.**^{7} **H04M 11/00**

(52) **U.S. Cl.** **379/93.01**; 379/90.01

(58) **Field of Search** 379/90.01, 102.01–102.03, 379/93.17, 93.26, 93.28, 93.37, 93.01; 348/14–16, 734, 7

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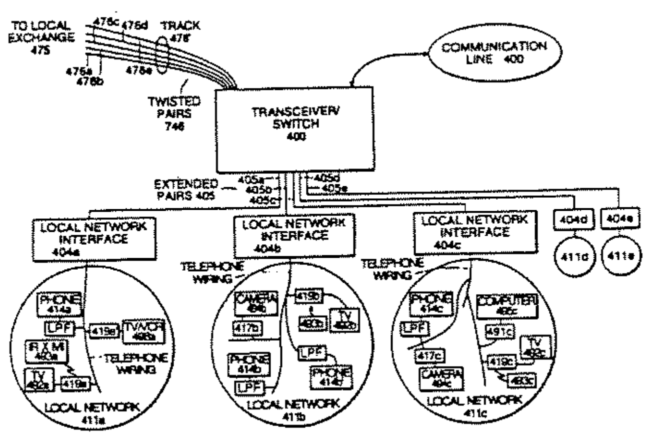
Primary Examiner—Wing F. Chan
(74) *Attorney, Agent, or Firm*—Fish & Richardson PC

(57) **ABSTRACT**

A system that provides video signal communication between a source of the video signal and a plurality of units that include destinations of the video signal includes an interface coupled to the source and to telephone lines, each of which serves at least one of the units and carries voice signals to and from one or more telephones coupled to the telephone line at said unit. The interface receives the video signal from the source, and transmits the received video signal onto at least one of the telephone lines in a selected frequency range that is different from frequencies at which the voice signals are carried on that telephone line. This causes the video signal to be coupled to a receiver which is connected to the telephone line at the unit served by that line and is adapted to recover the video signal from the telephone line and apply it to one or more of the destinations at the unit. The source is a cable (e.g., electrical or fiber optic) that is linked to the interface and that carries a plurality of video signals. The destinations are, e.g., televisions. The units can be residences (such as individual houses or apartments in an apartment building) or offices in an office building.

6 Claims, 25 Drawing Sheets



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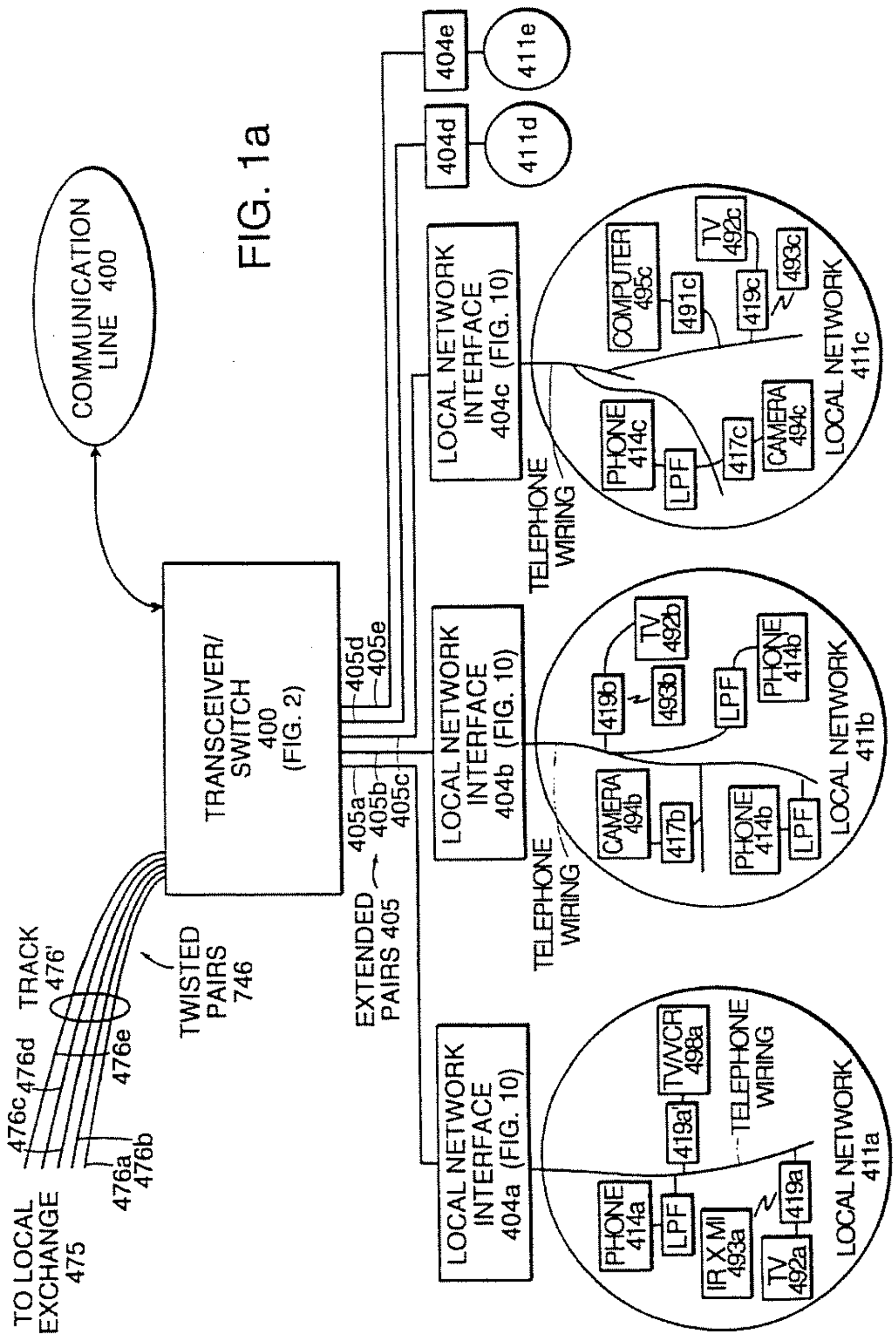

COMMUNICATION LINE 400
TRANSCEIVER/ SWITCH 400 (FIG. 2)
TO LOCAL EXCHANGE 475
TRACK 476'
476c
476d
476e
476a
476b
TWISTED PAIRS 746
EXTENDED PAIRS 405
405a
405b
405c
405d
405e
LOCAL NETWORK INTERFACE 404a (FIG. 10)
LOCAL NETWORK INTERFACE 404b (FIG. 10)
LOCAL NETWORK INTERFACE 404c (FIG. 10)
404d
404e
411d
411e
TELEPHONE WIRING
PHONE 414a
LPF
IR X MI 493a
TV 492a
419a
TV/VCR 498a
LOCAL NETWORK 411a
CAMERA 494b
417b
PHONE 414b
419b
493b
TV 492b
PHONE 414b
LOCAL NETWORK 411b
PHONE 414c
417c
CAMERA 494c
COMPUTER 495c
491c
419c
TV 492c
493c
LOCAL NETWORK 411c

FIG. 1a

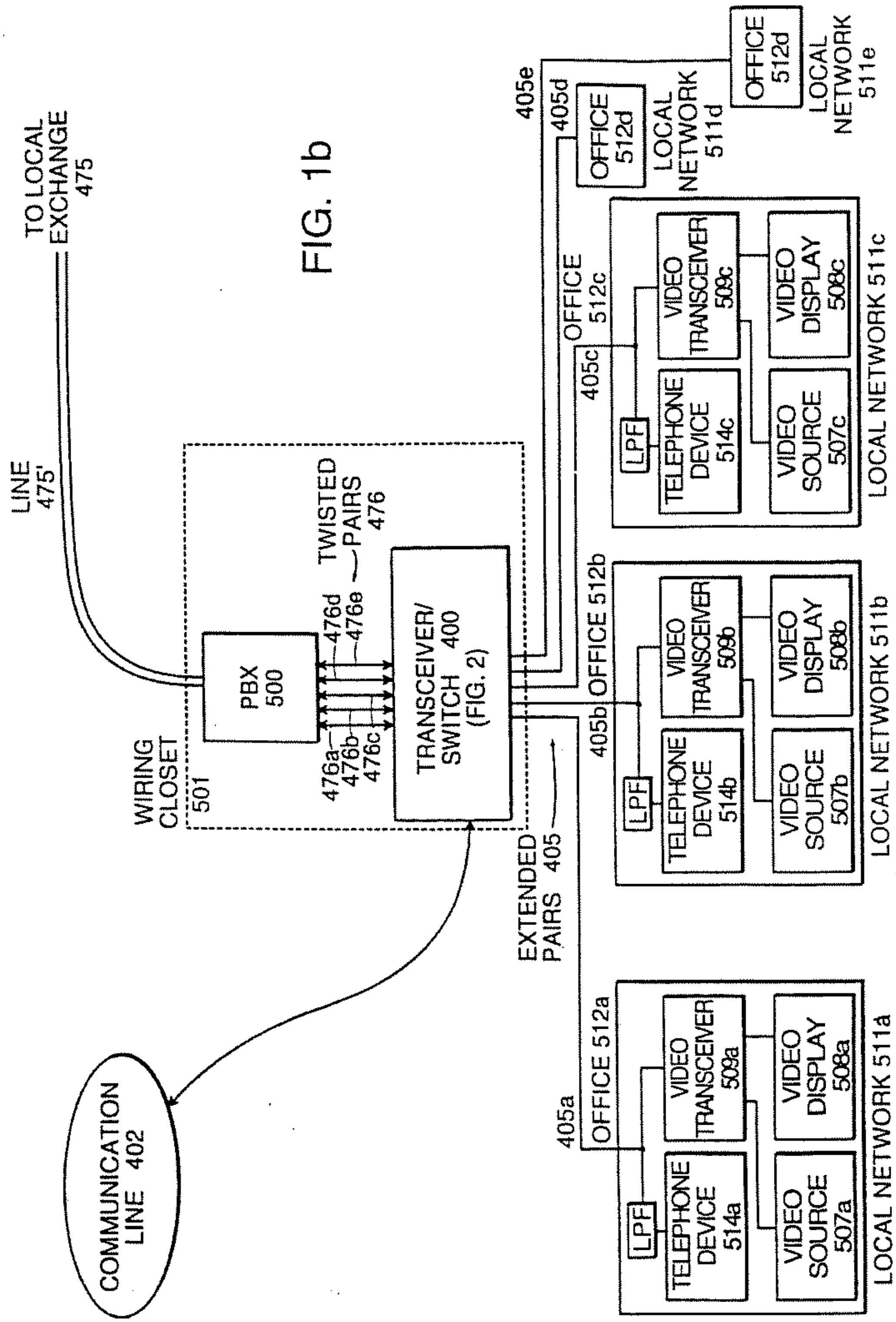

TO LOCAL EXCHANGE 475
LINE 475'
WIRING CLOSET 501
PBX 500
476a
476b
476c
476d
476e
TWISTED PAIRS 476
TRANSCEIVER/ SWITCH 400 (FIG. 2)
EXTENDED PAIRS 405
COMMUNICATION LINE 402
405a
405b
405c
405d
405e
OFFICE 512a
OFFICE 512b
OFFICE 512c
OFFICE 512d
LPF
TELEPHONE DEVICE 514a
VIDEO TRANSCEIVER 509a
VIDEO SOURCE 507a
VIDEO DISPLAY 508a
LOCAL NETWORK 511a
TELEPHONE DEVICE 514b
VIDEO TRANSCEIVER 509b
VIDEO SOURCE 507b
VIDEO DISPLAY 508b
LOCAL NETWORK 511b
TELEPHONE DEVICE 514c
VIDEO TRANSCEIVER 509c
VIDEO SOURCE 507c
VIDEO DISPLAY 508c
LOCAL NETWORK 511c
LOCAL NETWORK 511d
LOCAL NETWORK 511e

FIG. 1b

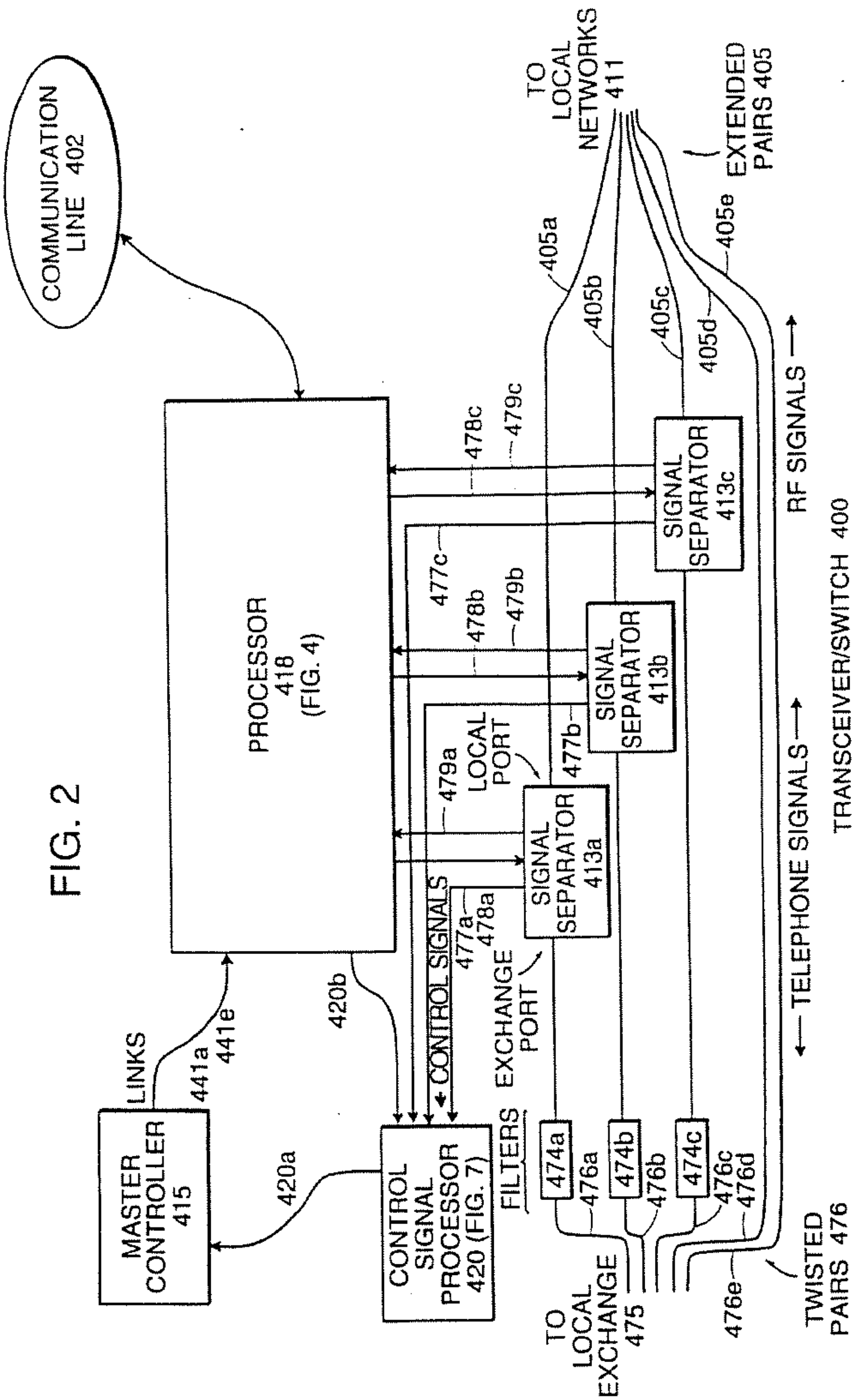
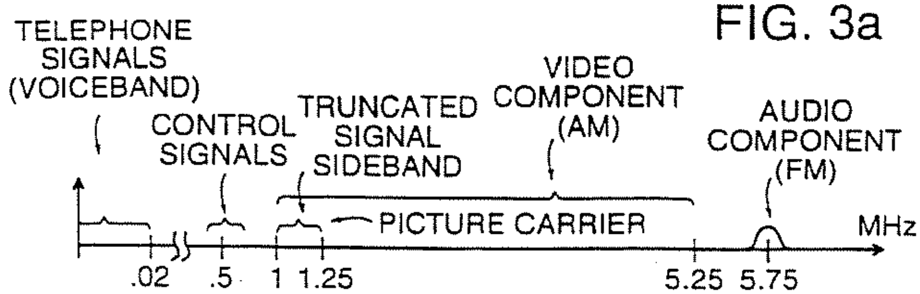

COMMUNICATION LINE 402
PROCESSOR 418 (FIG. 4)
MASTER CONTROLLER 415
LINKS
441a
441e
420a
420b
CONTROL SIGNAL PROCESSOR 420 (FIG. 7)
CONTROL SIGNALS
SIGNAL SEPARATOR 413a
SIGNAL SEPARATOR 413b
SIGNAL SEPARATOR 413c
477a
478a
479a
477b
478b
479b
477c
478c
479c
LOCAL PORT
EXCHANGE PORT
FILTERS
474a
474b
474c
476a
476b
476c
476d
476e
TO LOCAL EXCHANGE 475
TWISTED PAIRS 476
TO LOCAL NETWORKS 411
EXTENDED PAIRS 405
405a
405b
405c
405d
405e
RF SIGNALS
TELEPHONE SIGNALS
TRANSCEIVER/SWITCH 400

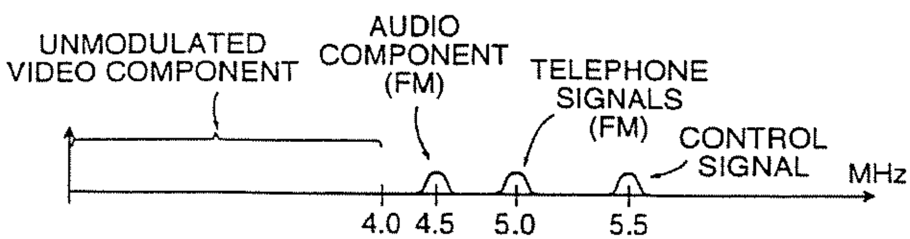
FIG. 2

FIG. 3a



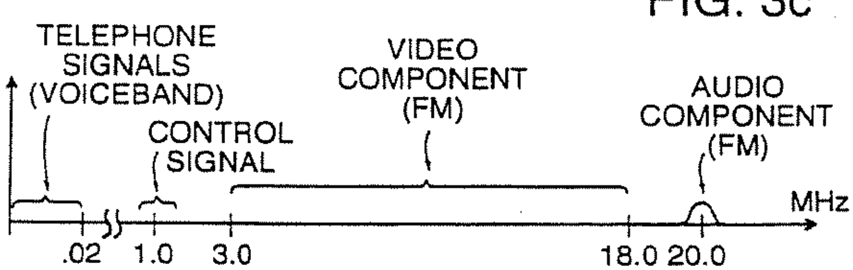
SPECTRUM OF AN AMPLITUDE MODULATED NTSC SIGNAL NEAR VOICEBAND

FIG. 3b



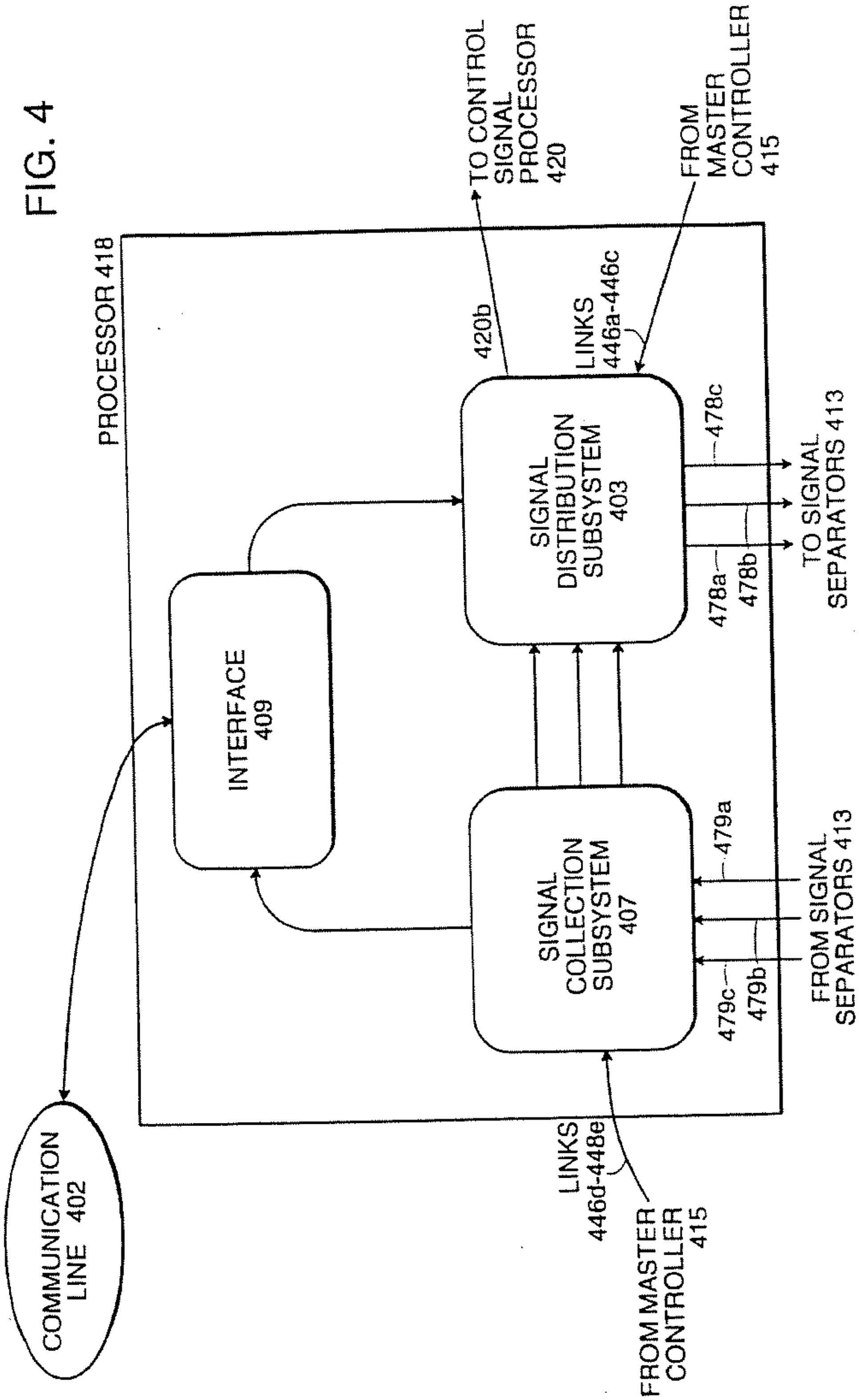
SPECTRUM OF AN NTSC SIGNAL TRANSMITTING AT BASEBAND

FIG. 3c



SPECTRUM OF AN FM NTSC SIGNAL NEAR VOICEBAND

FIG. 4


PROCESSOR 418
TO CONTROL SIGNAL PROCESSOR 420
FROM MASTER CONTROLLER 415
420b
LINKS 446a-446c
SIGNAL DISTRIBUTION SUBSYSTEM 403
478c
478a
478b
TO SIGNAL SEPARATORS 413
INTERFACE 409
SIGNAL COLLECTION SUBSYSTEM 407
479a
479c
479b
FROM SIGNAL SEPARATORS 413
COMMUNICATION LINE 402
LINKS 446d-448e
FROM MASTER CONTROLLER 415

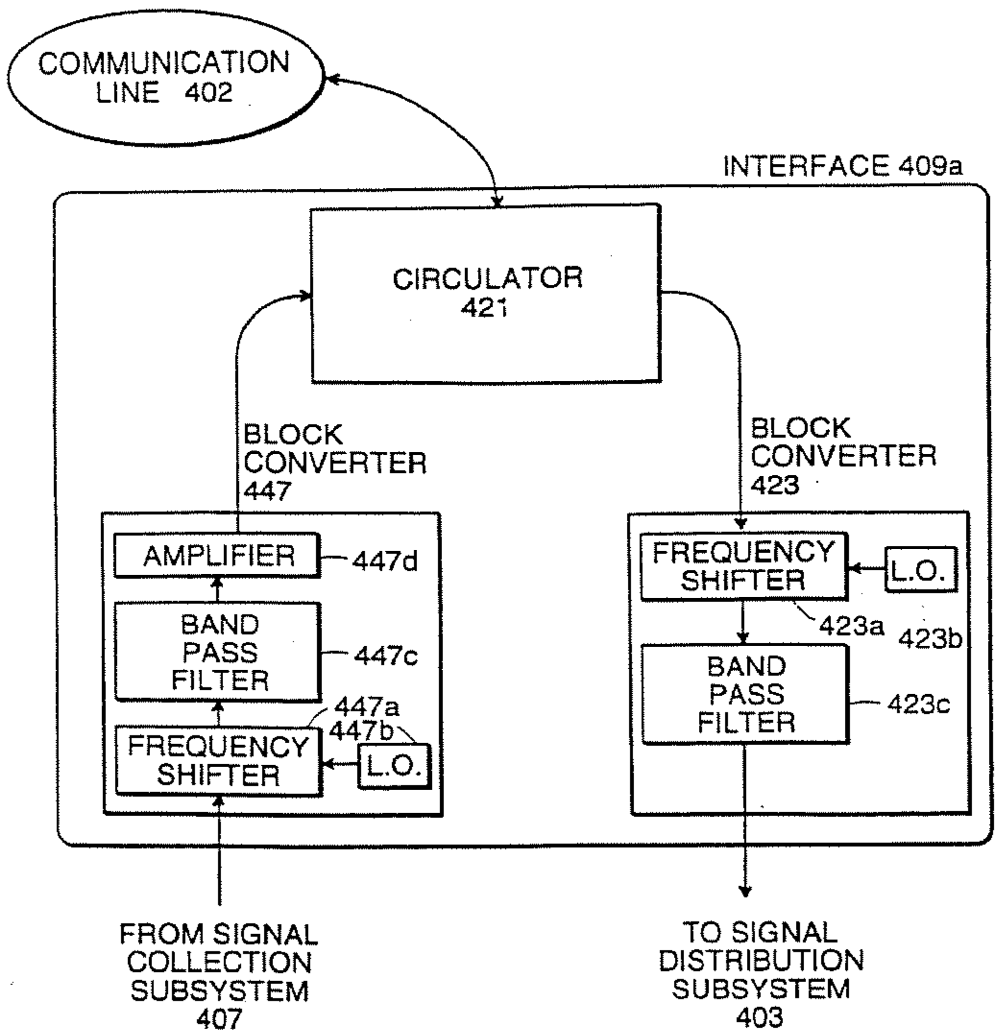

COMMUNICATION LINE 402
INTERFACE 409a
CIRCULATOR 421
BLOCK CONVERTER 447
BLOCK CONVERTER 423
AMPLIFIER
447d
BAND PASS FILTER
447c
447a
447b
FREQUENCY SHIFTER
L.O.
FREQUENCY SHIFTER
L.O.
423a
423b
BAND PASS FILTER
423c
FROM SIGNAL COLLECTION SUBSYSTEM 407
TO SIGNAL DISTRIBUTION SUBSYSTEM 403

FIG. 4a

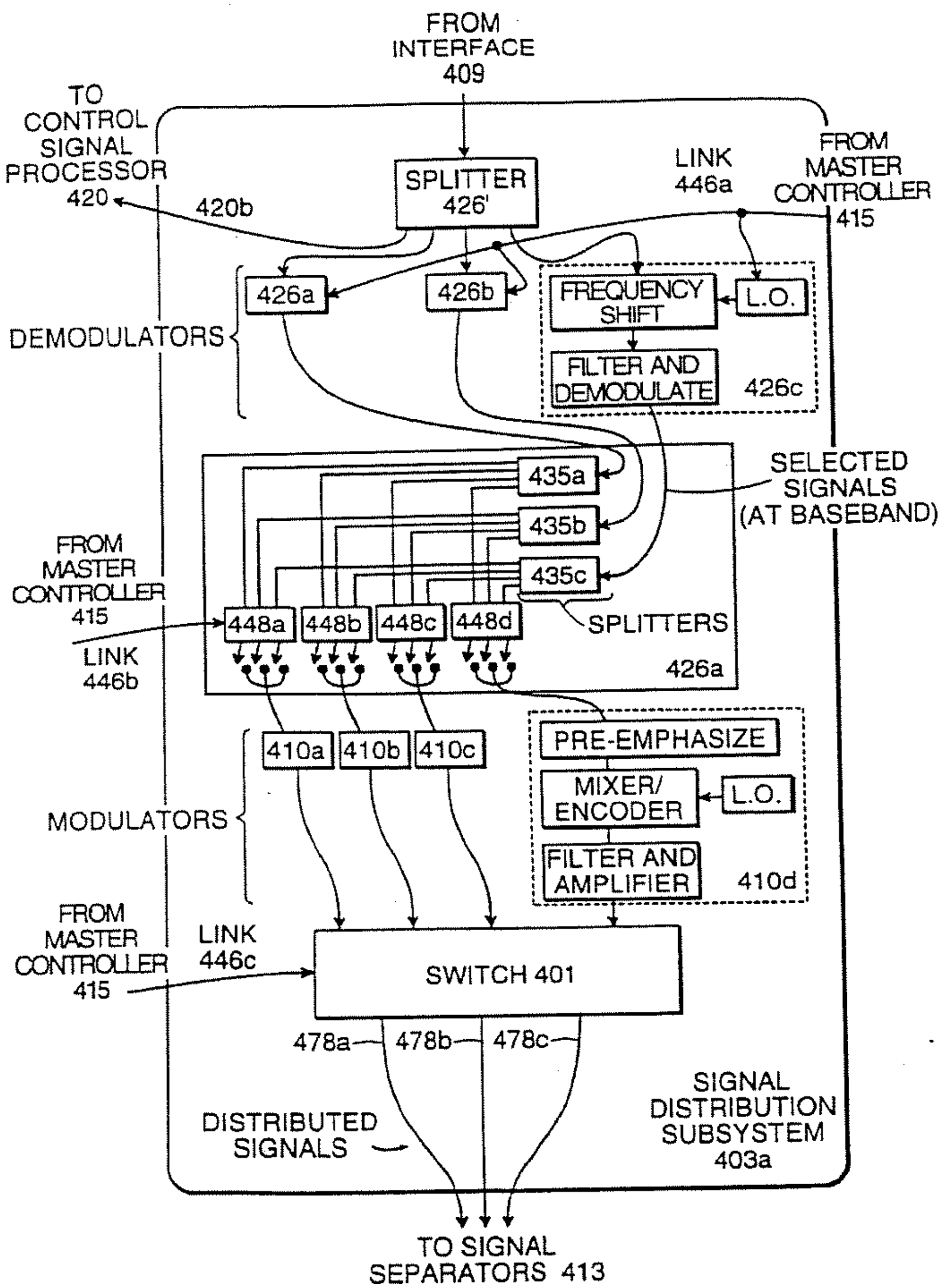

FROM INTERFACE 409
TO CONTROL SIGNAL PROCESSOR 420
420b
SPLITTER 426'
LINK 446a
FROM MASTER CONTROLLER 415
426a
426b
FREQUENCY SHIFT
L.O.
FILTER AND DEMODULATE
426c
DEMODULATORS
435a
435b
435c
SELECTED SIGNALS (AT BASEBAND)
FROM MASTER CONTROLLER 415
448a
448b
448c
448d
SPLITTERS
LINK 446b
426a
PRE-EMPHASIZE
410a
410b
410c
MIXER/ ENCODER
L.O.
MODULATORS
FILTER AND AMPLIFIER
410d
FROM MASTER CONTROLLER 415
LINK 446c
SWITCH 401
478a
478b
478c
SIGNAL DISTRIBUTION SUBSYSTEM 403a
DISTRIBUTED SIGNALS
TO SIGNAL SEPARATORS 413

FIG. 5a

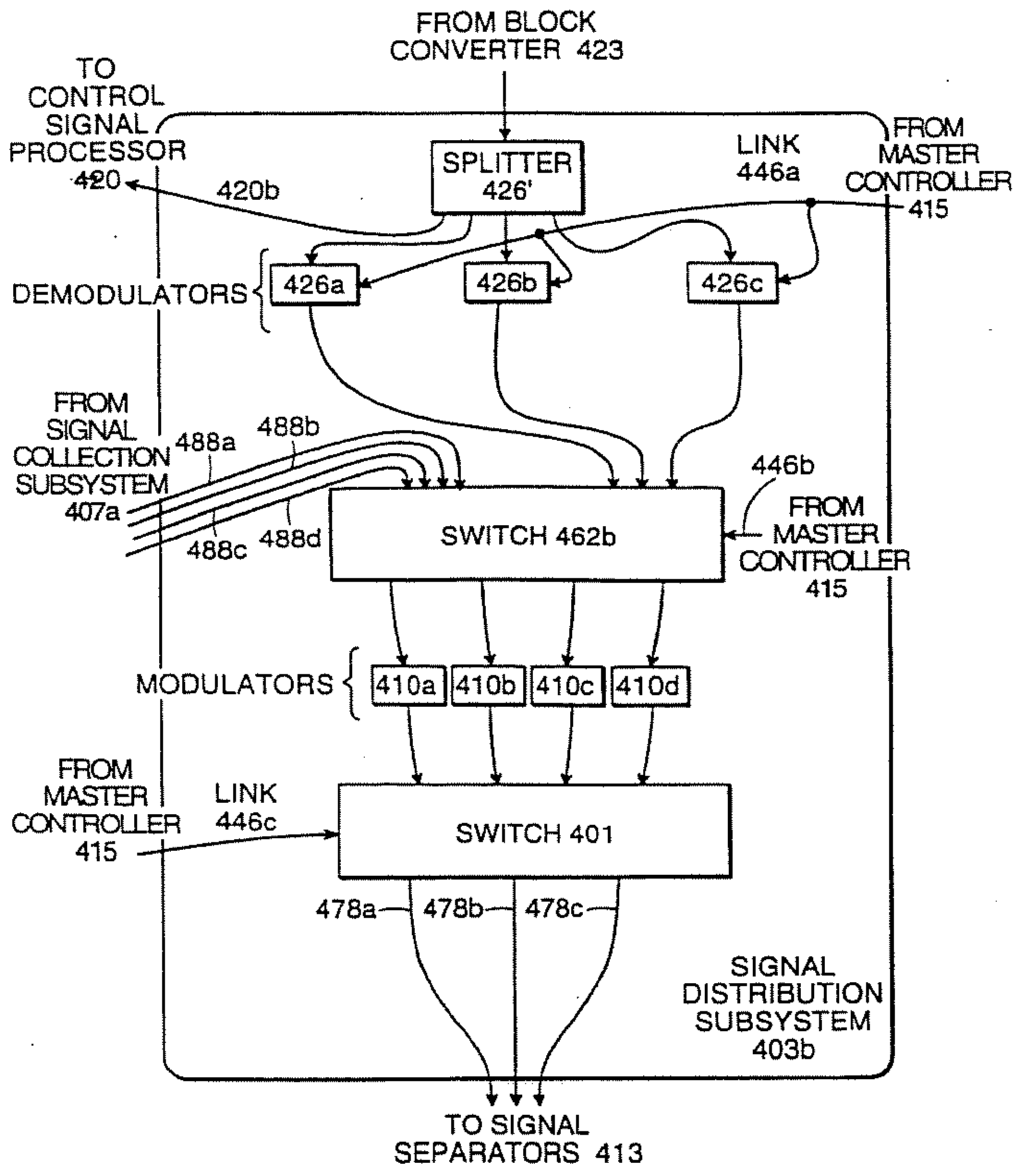

FROM BLOCK
CONVERTER 423
TO
CONTROL
SIGNAL
PROCESSOR
420
420b
SPLITTER
426'
LINK
446a
FROM
MASTER
CONTROLLER
415
DEMODULATORS
426a
426b
426c
FROM
SIGNAL
COLLECTION
SUBSYSTEM
407a
488a
488b
488c
488d
446b
SWITCH 462b
FROM
MASTER
CONTROLLER
415
MODULATORS
410a
410b
410c
410d
FROM
MASTER
CONTROLLER
415
LINK
446c
SWITCH 401
478a
478b
478c
SIGNAL
DISTRIBUTION
SUBSYSTEM
403b
TO SIGNAL
SEPARATORS 413

FIG. 5b

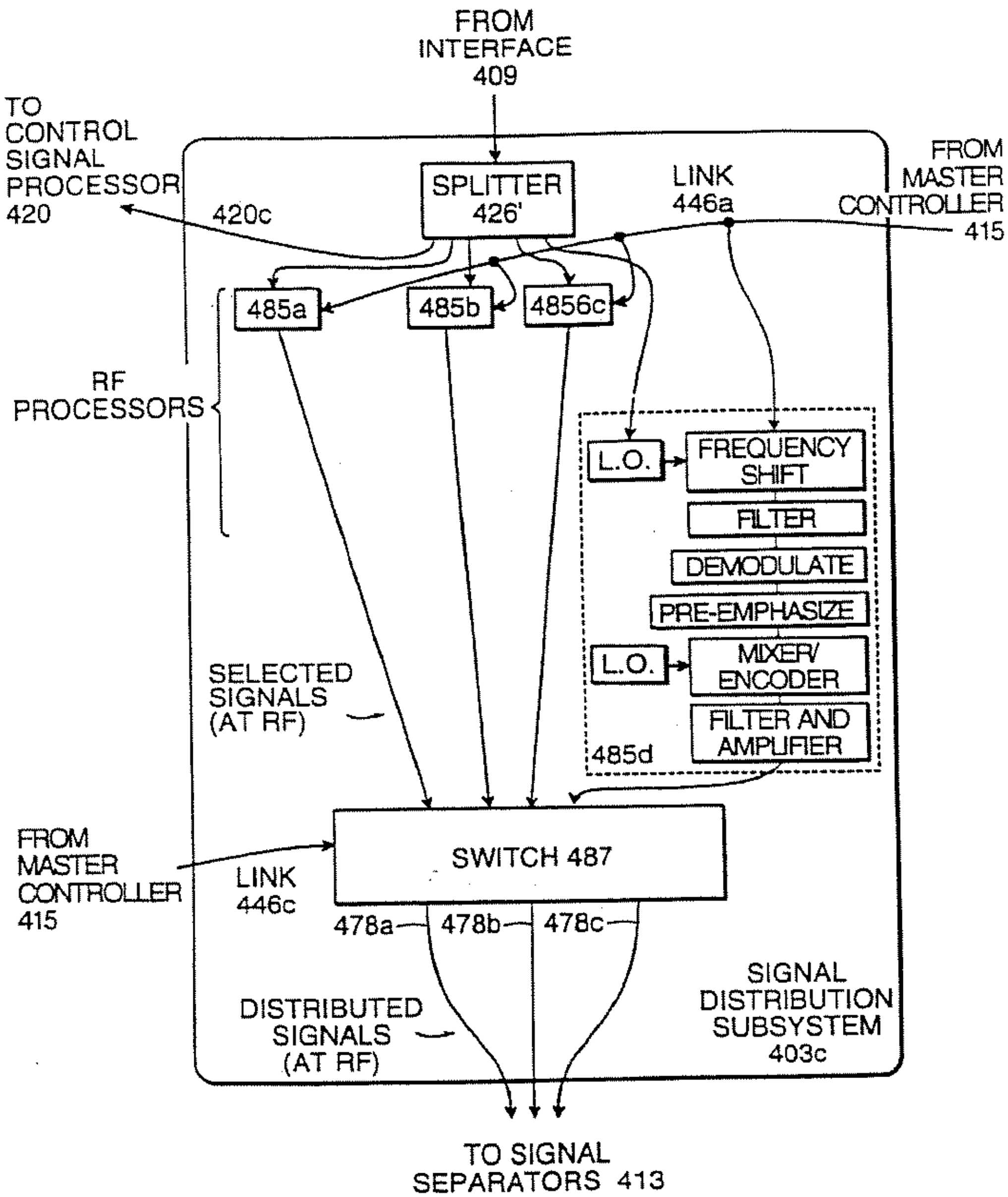

FROM
INTERFACE
409
TO
CONTROL
SIGNAL
PROCESSOR
420
420c
SPLITTER
426'
LINK
446a
FROM
MASTER
CONTROLLER
415
485a
485b
4856c
RF
PROCESSORS
L.O.
FREQUENCY
SHIFT
FILTER
DEMODULATE
PRE-EMPHASIZE
L.O.
MIXER/
ENCODER
FILTER AND
AMPLIFIER
485d
SELECTED
SIGNALS
(AT RF)
FROM
MASTER
CONTROLLER
415
LINK
446c
SWITCH 487
478a
478b
478c
DISTRIBUTED
SIGNALS
(AT RF)
SIGNAL
DISTRIBUTION
SUBSYSTEM
403c
TO SIGNAL
SEPARATORS 413

FIG. 5c

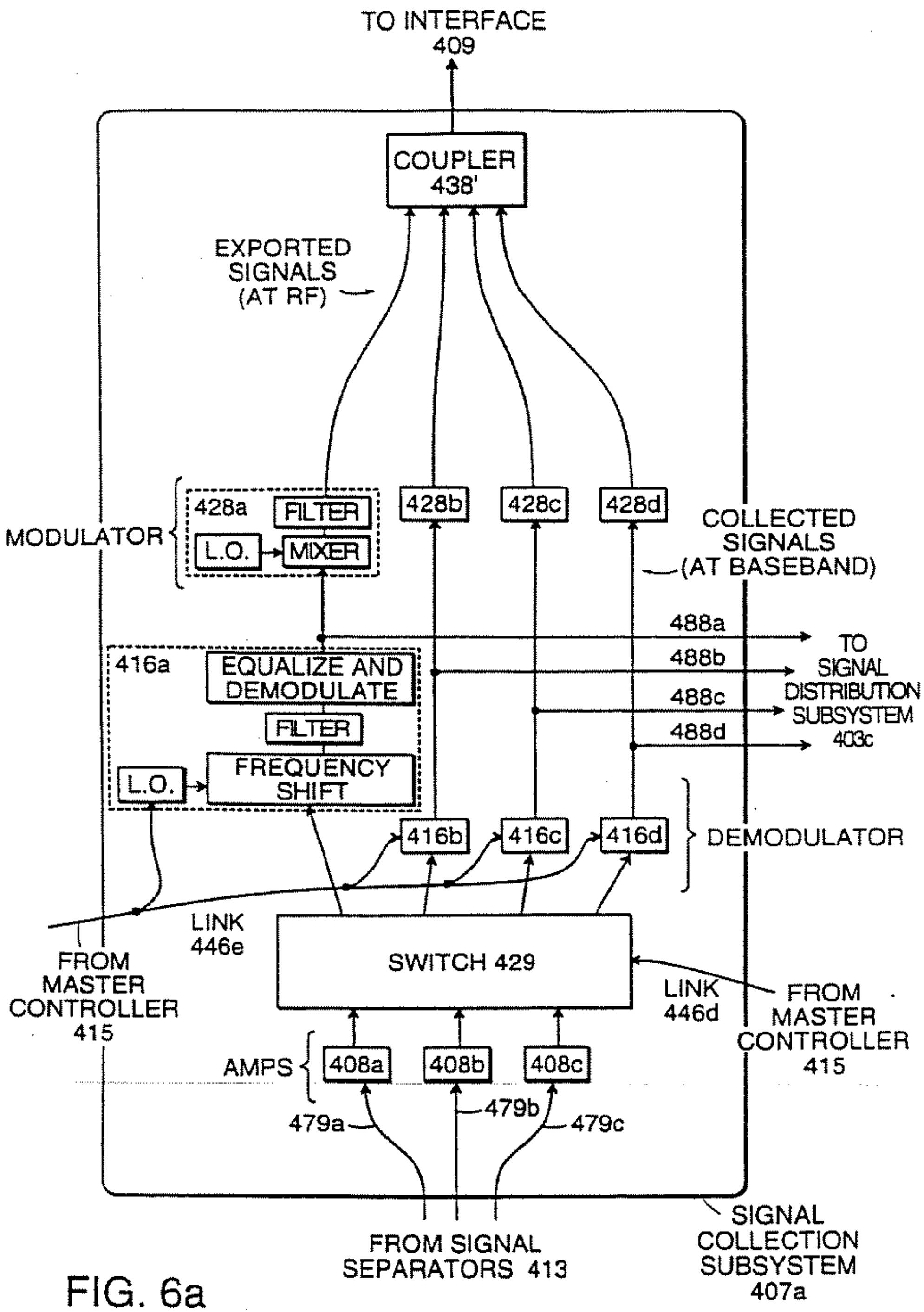
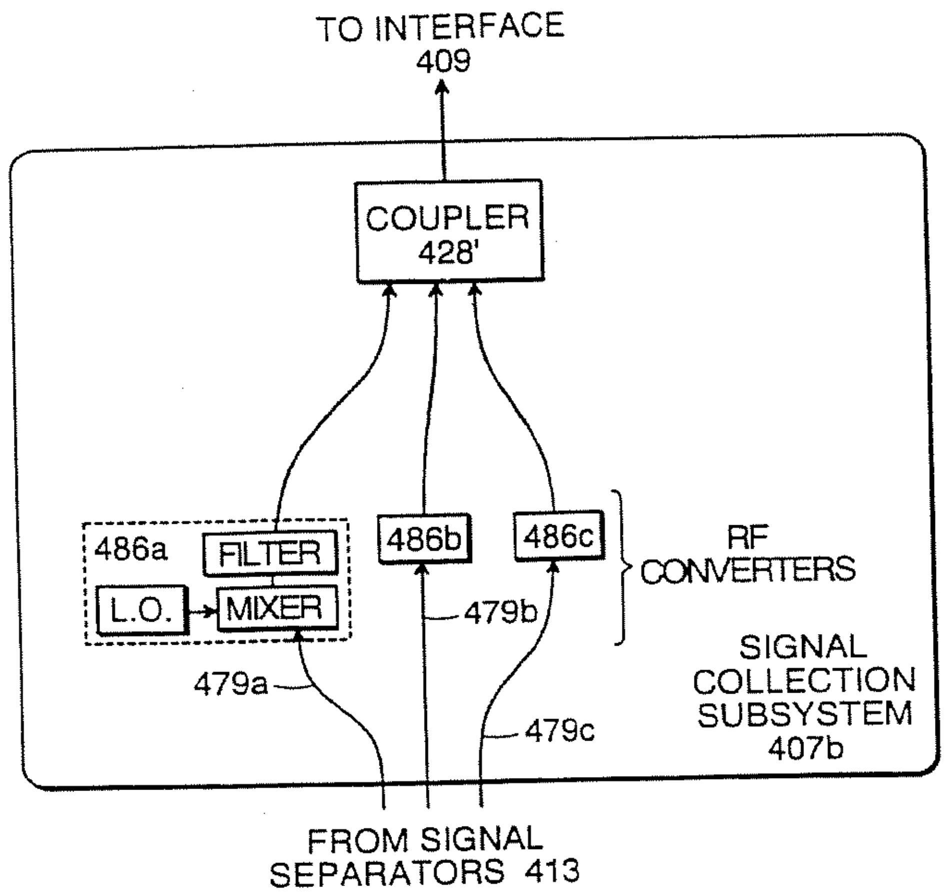

TO INTERFACE 409
COUPLER 438'
EXPORTED SIGNALS (AT RF)
MODULATOR
428a
FILTER
L.O.
MIXER
428b
428c
428d
COLLECTED SIGNALS (AT BASEBAND)
488a
488b
488c
488d
TO SIGNAL DISTRIBUTION SUBSYSTEM 403c
416a
EQUALIZE AND DEMODULATE
FILTER
FREQUENCY SHIFT
L.O.
416b
416c
416d
DEMODULATOR
LINK 446e
SWITCH 429
LINK 446d
FROM MASTER CONTROLLER 415
FROM MASTER CONTROLLER 415
AMPS
408a
408b
408c
479a
479b
479c
FROM SIGNAL SEPARATORS 413
SIGNAL COLLECTION SUBSYSTEM 407a

FIG. 6a



TO INTERFACE 409
COUPLER 428'
486a
FILTER
L.O.
MIXER
486b
486c
RF CONVERTERS
479a
479b
479c
SIGNAL COLLECTION SUBSYSTEM 407b
FROM SIGNAL SEPARATORS 413

FIG. 6b

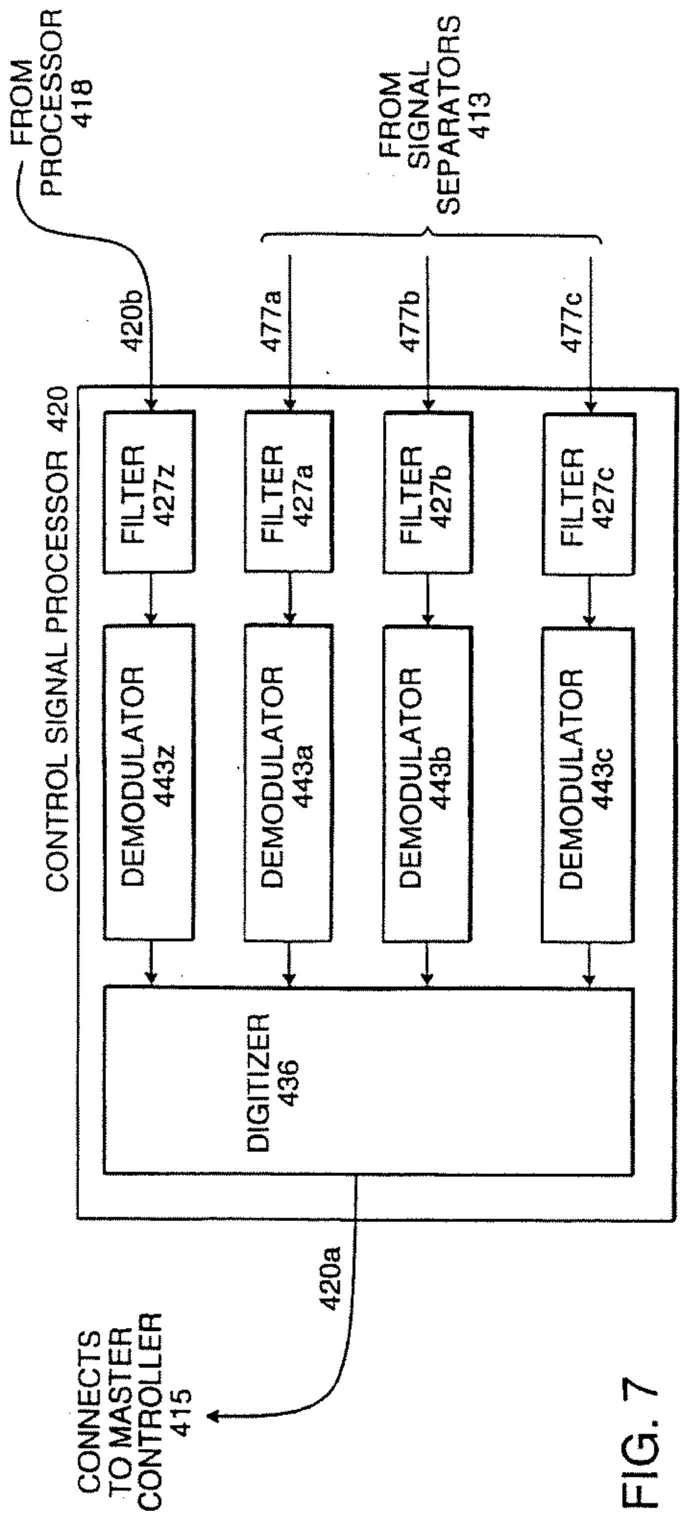

FROM
PROCESSOR
418
FROM
SIGNAL
SEPARATORS
413
420b
477a
477b
477c
CONTROL SIGNAL PROCESSOR 420
FILTER
427z
FILTER
427a
FILTER
427b
FILTER
427c
DEMODULATOR
443z
DEMODULATOR
443a
DEMODULATOR
443b
DEMODULATOR
443c
DIGITIZER
436
420a
CONNECTS
TO MASTER
CONTROLLER
415

FIG. 7

FIG. 8

		FREQUENCY DURING TRANSMISSION OVER EXTENDED PAIRS (MHz)			FREQUENCY DURING TRANSMISSION OVER LOCAL NETWORKS (MHz)		
	ORIGIN/DEST	405a	405b	405c	411a	411b	411c
CONTROL A	493a/415	22.75-23.25			22.75-23.25		
B	493b/415		22.75-23.25			22.75-23.25	
C	493c/415			22.75-23.25			22.75-23.25
VIDEO U	402/492a	1-6(AM)			12-18(AM)		
V	402/492b 492c 498a	7-22(FM)	1-6(AM)	1-6(AM)	24-30(AM)	54-60(AM)	12-18(AM)
W	494b/402		24-54(FM)			6-12(AM)	
X	494c/402			24-54(FM)			6-12(AM)
DIGITAL Y	402/495c			6-18			18-40
Z	495c/402			54-100			1-6

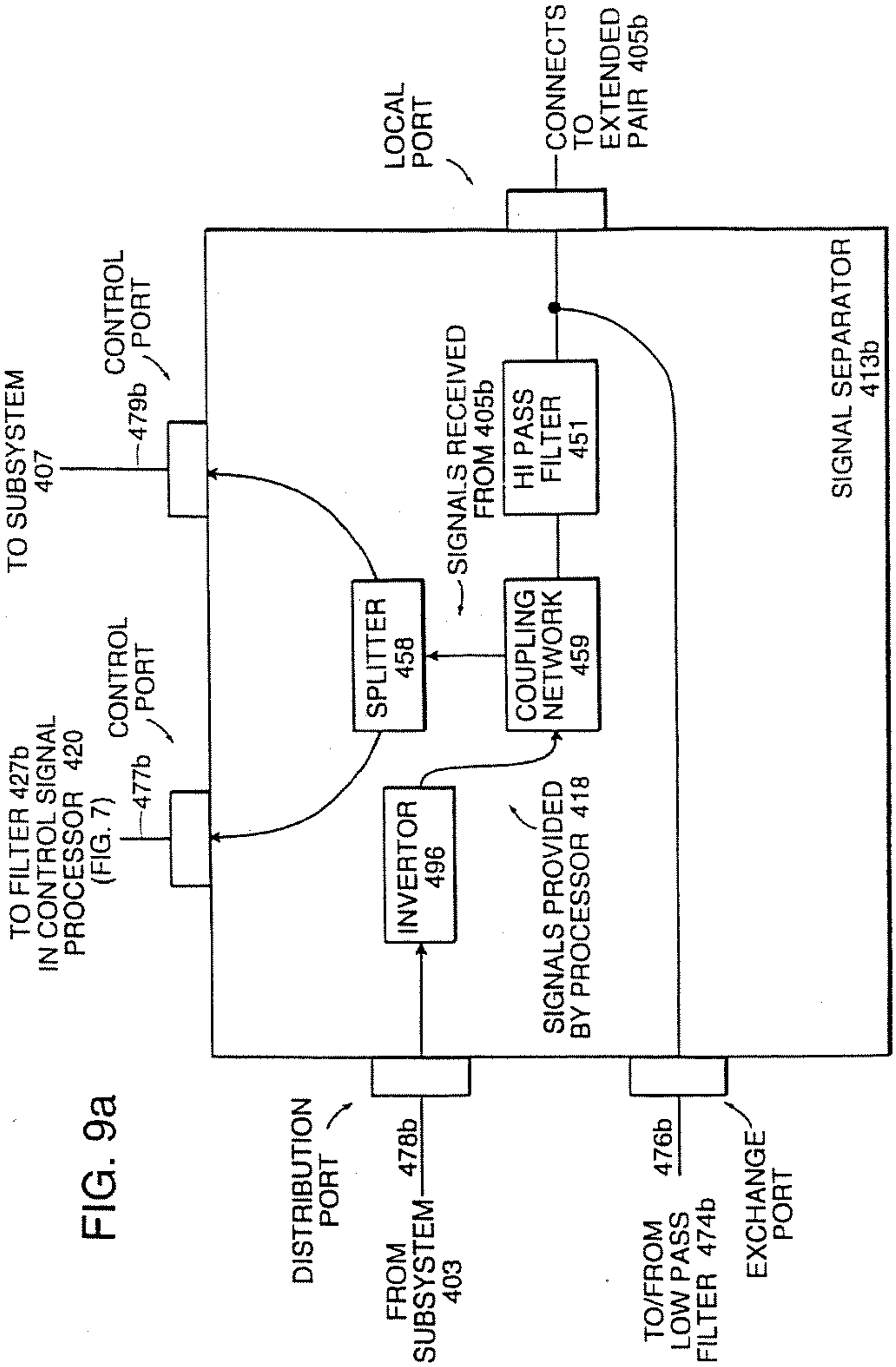

LOCAL PORT
CONNECTS TO EXTENDED PAIR 405b
CONTROL PORT
479b
TO SUBSYSTEM 407
SIGNALS RECEIVED FROM 405b
HI PASS FILTER 451
SIGNAL SEPARATOR 413b
SPLITTER 458
COUPLING NETWORK 459
CONTROL PORT
477b
TO FILTER 427b IN CONTROL SIGNAL PROCESSOR 420 (FIG. 7)
INVERTOR 496
SIGNALS PROVIDED BY PROCESSOR 418
DISTRIBUTION PORT
478b
FROM SUBSYSTEM 403
476b
TO/FROM LOW PASS FILTER 474b
EXCHANGE PORT

FIG. 9a

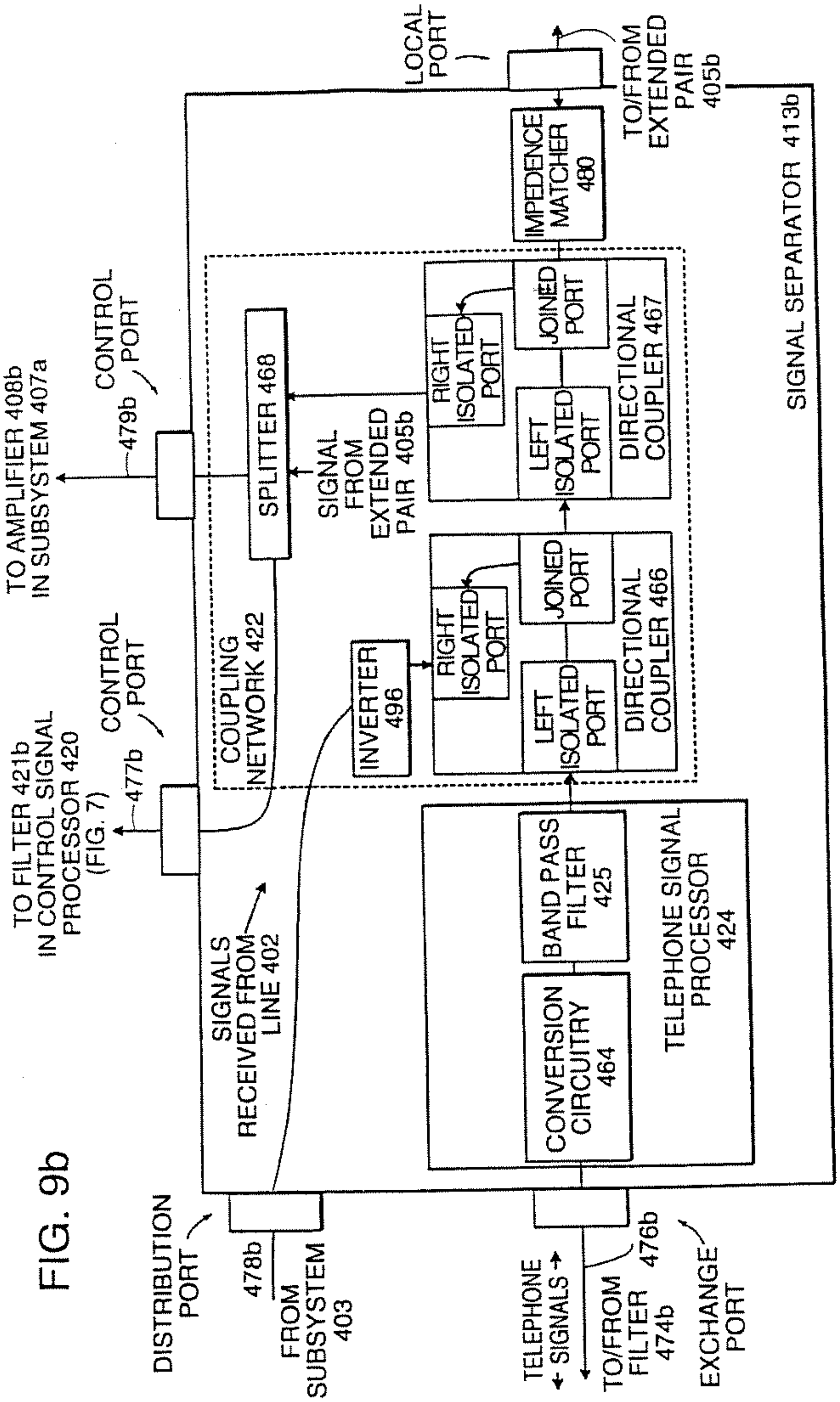

LOCAL PORT
TO/FROM EXTENDED PAIR 405b
IMPEDENCE MATCHER 480
SIGNAL SEPARATOR 413b
CONTROL PORT
479b
TO AMPLIFIER 408b IN SUBSYSTEM 407a
SPLITTER 468
SIGNAL FROM EXTENDED PAIR 405b
RIGHT ISOLATED PORT
JOINED PORT
LEFT ISOLATED PORT
DIRECTIONAL COUPLER 467
COUPLING NETWORK 422
INVERTER 496
DIRECTIONAL COUPLER 466
TO FILTER 421b IN CONTROL SIGNAL PROCESSOR 420 (FIG. 7)
477b
SIGNALS RECEIVED FROM LINE 402
BAND PASS FILTER 425
CONVERSION CIRCUITRY 464
TELEPHONE SIGNAL PROCESSOR 424
DISTRIBUTION PORT
478b
FROM SUBSYSTEM 403
TELEPHONE SIGNALS
TO/FROM FILTER 474b
476b
EXCHANGE PORT

FIG. 9b

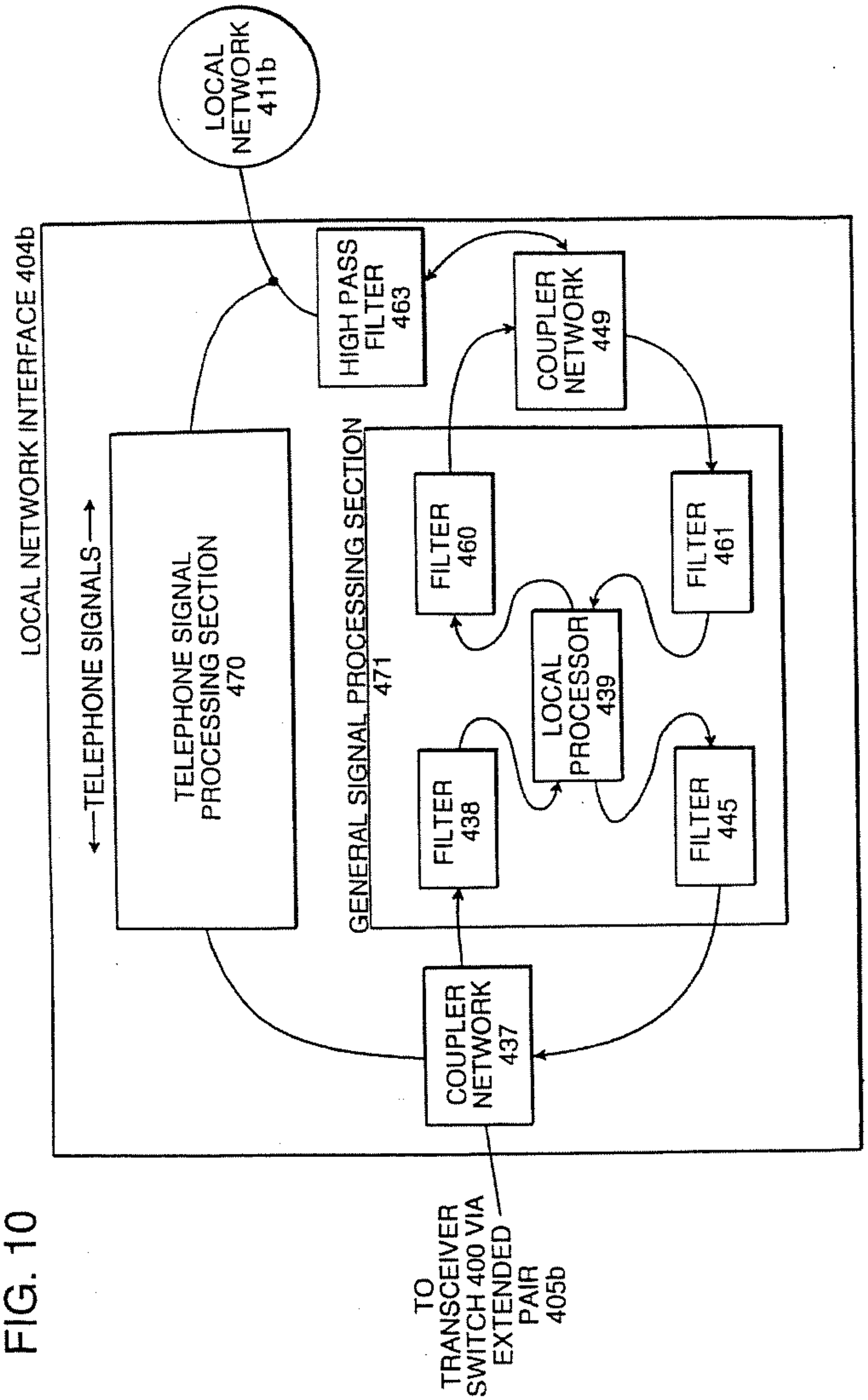

LOCAL NETWORK 411b
LOCAL NETWORK INTERFACE 404b
HIGH PASS FILTER 463
COUPLER NETWORK 449
TELEPHONE SIGNALS
TELEPHONE SIGNAL PROCESSING SECTION 470
GENERAL SIGNAL PROCESSING SECTION 471
FILTER 460
FILTER 461
LOCAL PROCESSOR 439
FILTER 438
FILTER 445
COUPLER NETWORK 437
TO TRANSCEIVER SWITCH 400 VIA EXTENDED PAIR 405b

FIG. 10

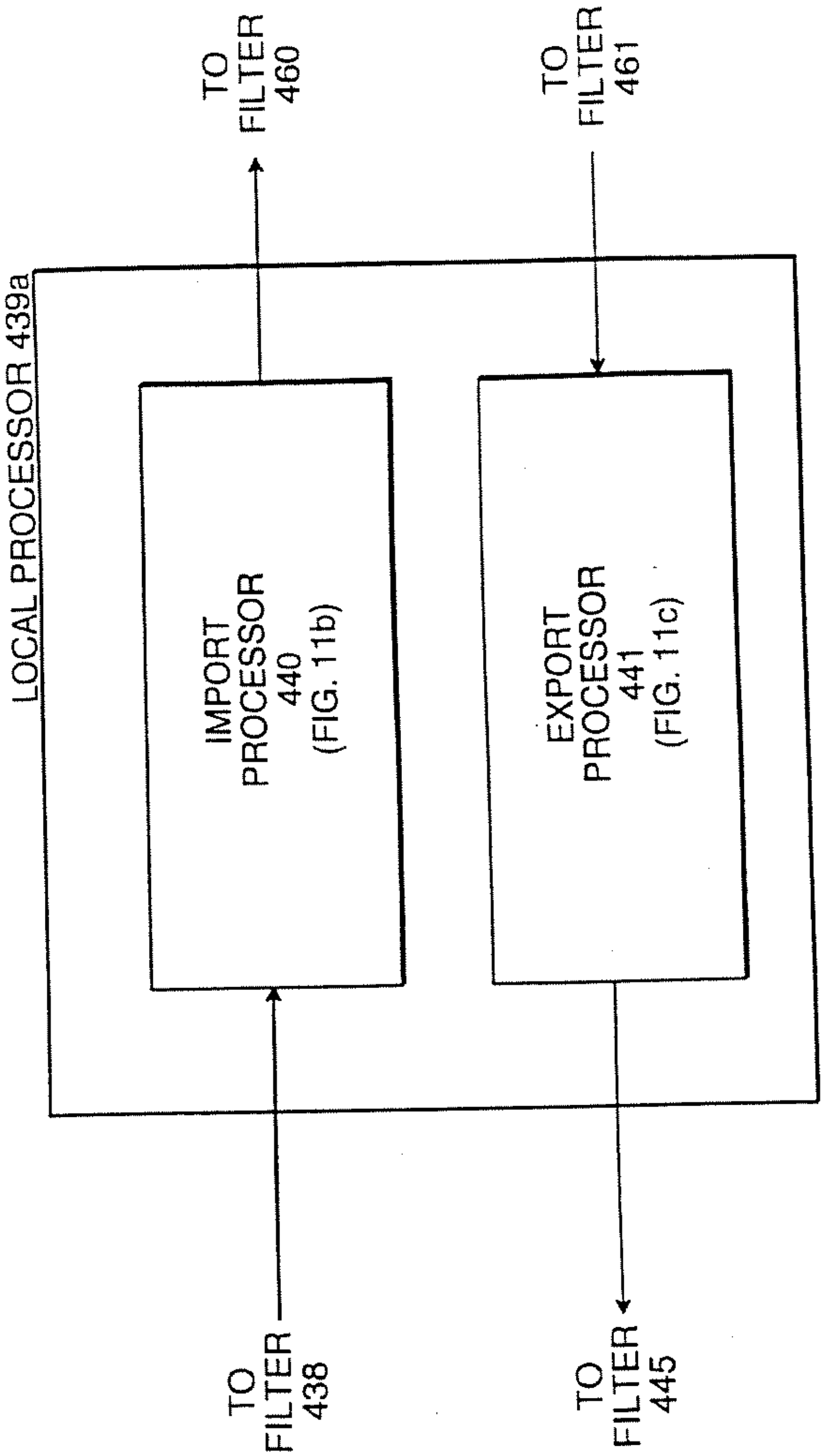

LOCAL PROCESSOR 439a
TO FILTER 460
TO FILTER 461
IMPORT PROCESSOR 440 (FIG. 11b)
EXPORT PROCESSOR 441 (FIG. 11c)
TO FILTER 438
TO FILTER 445

FIG. 11a

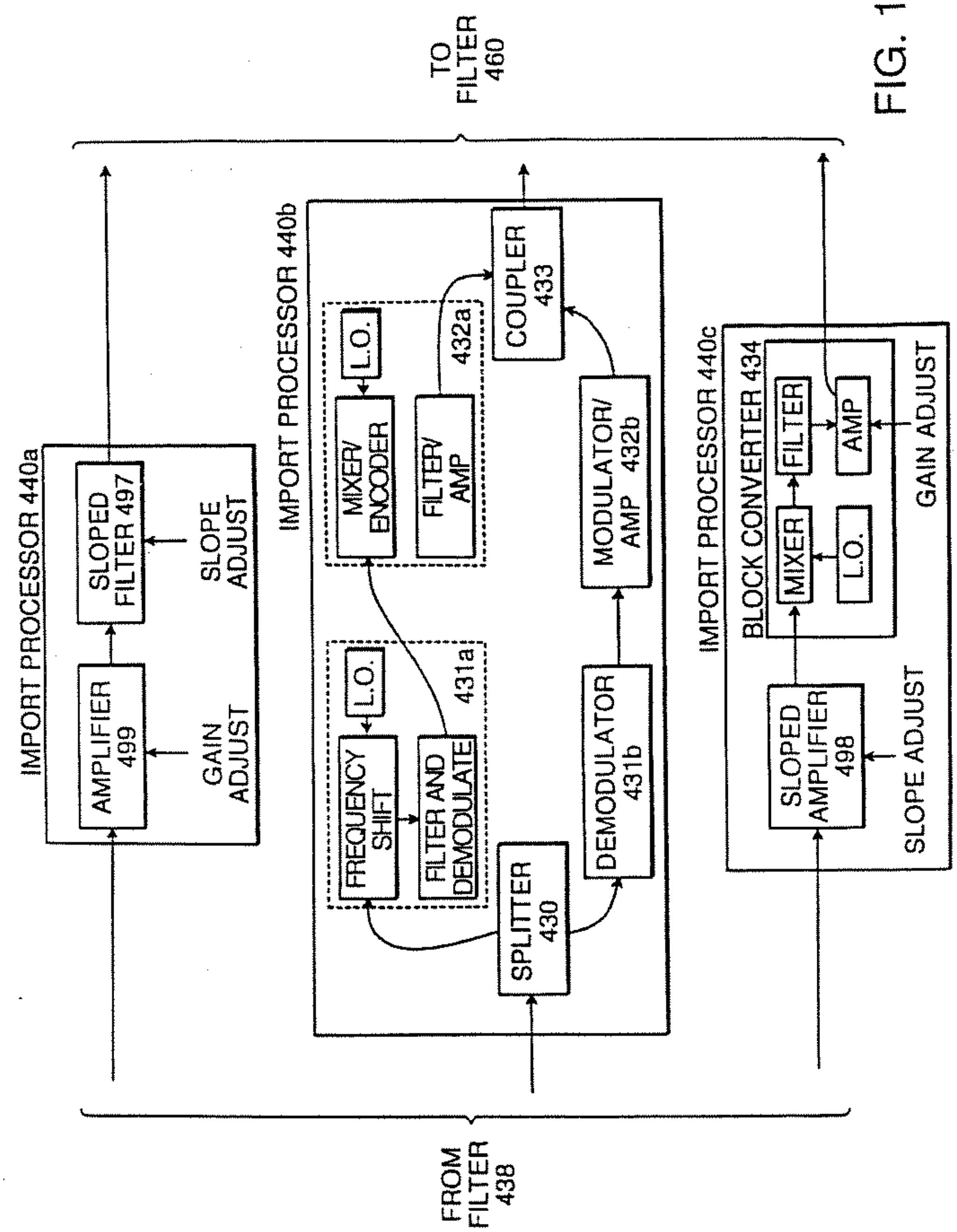

TO FILTER 460
IMPORT PROCESSOR 440a
AMPLIFIER 499
SLOPED FILTER 497
GAIN ADJUST
SLOPE ADJUST
IMPORT PROCESSOR 440b
L.O.
FREQUENCY SHIFT
FILTER AND DEMODULATE
431a
L.O.
MIXER/ ENCODER
FILTER/ AMP
432a
SPLITTER 430
DEMODULATOR 431b
MODULATOR/ AMP 432b
COUPLER 433
IMPORT PROCESSOR 440c
BLOCK CONVERTER 434
MIXER
L.O.
FILTER
AMP
SLOPED AMPLIFIER 498
SLOPE ADJUST
GAIN ADJUST
FROM FILTER 438

FIG. 11b

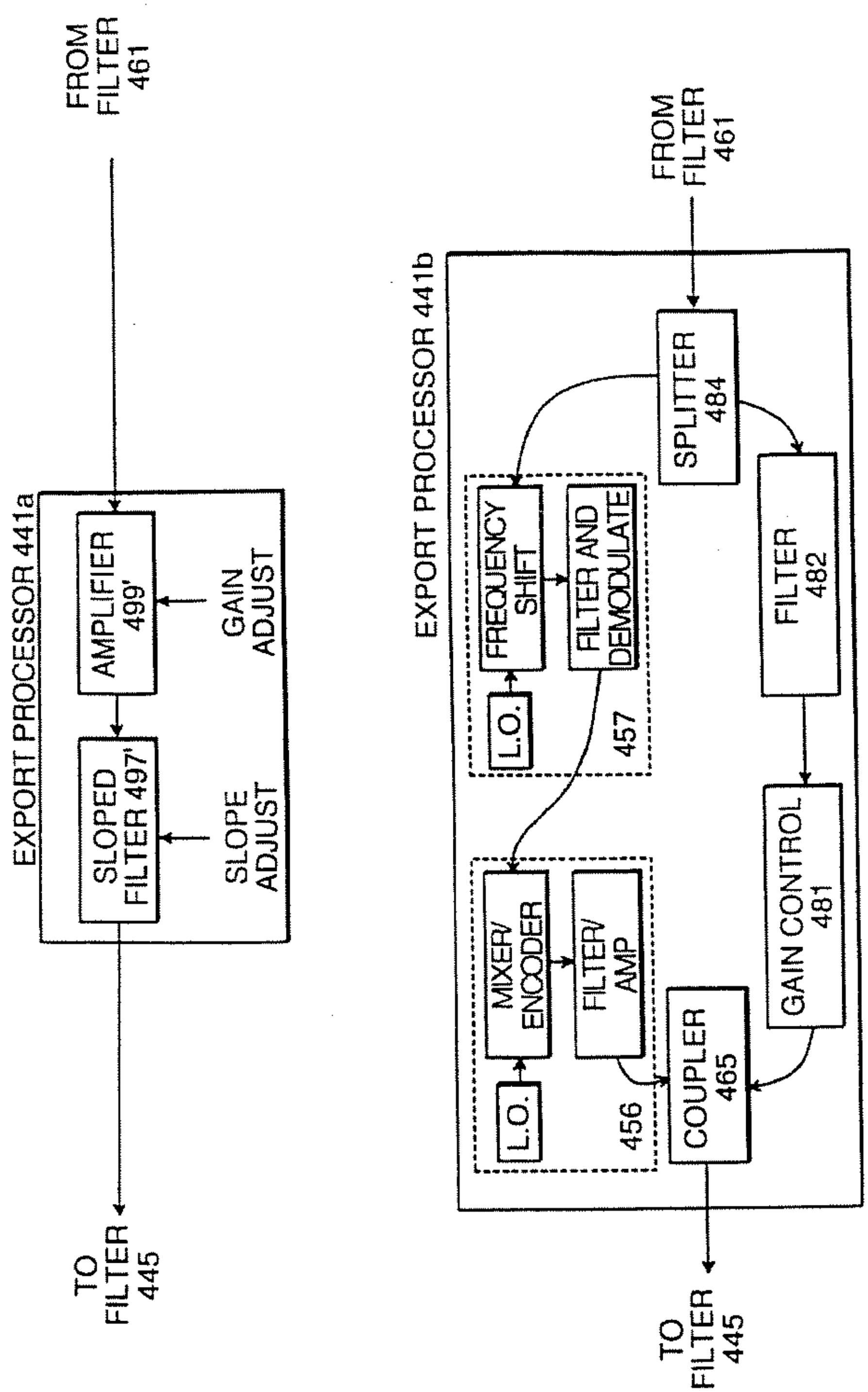

FROM FILTER 461
EXPORT PROCESSOR 441a
AMPLIFIER 499'
GAIN ADJUST
SLOPED FILTER 497'
SLOPE ADJUST
TO FILTER 445
FROM FILTER 461
EXPORT PROCESSOR 441b
SPLITTER 484
FREQUENCY SHIFT
FILTER AND DEMODULATE
L.O.
457
FILTER 482
MIXER/ ENCODER
FILTER/ AMP
L.O.
456
GAIN CONTROL 481
COUPLER 465
TO FILTER 445

FIG. 11c

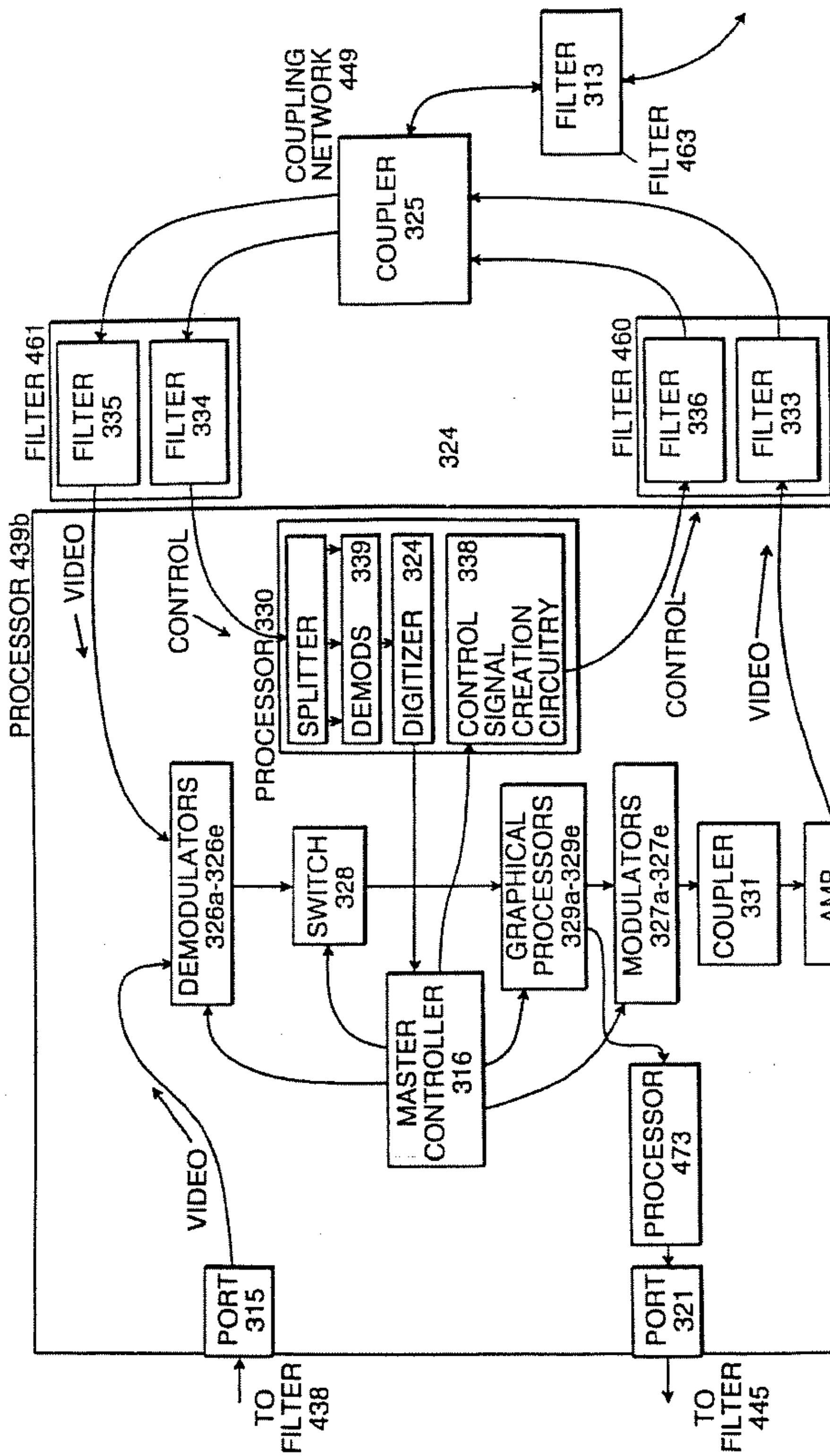

COUPLING NETWORK 449
FILTER 313
FILTER 463
COUPLER 325
FILTER 461
FILTER 335
FILTER 334
324
FILTER 460
FILTER 336
FILTER 333
PROCESSOR 439b
VIDEO
CONTROL
PROCESSOR 330
SPLITTER
DEMODS 339
DIGITIZER 324
CONTROL SIGNAL CREATION CIRCUITRY 338
CONTROL
VIDEO
DEMODULATORS 326a-326e
SWITCH 328
GRAPHICAL PROCESSORS 329a-329e
MODULATORS 327a-327e
COUPLER 331
AMP 332
MASTER CONTROLLER 316
PROCESSOR 473
VIDEO
PORT 315
PORT 321
TO FILTER 438
TO FILTER 445

FIG. 12

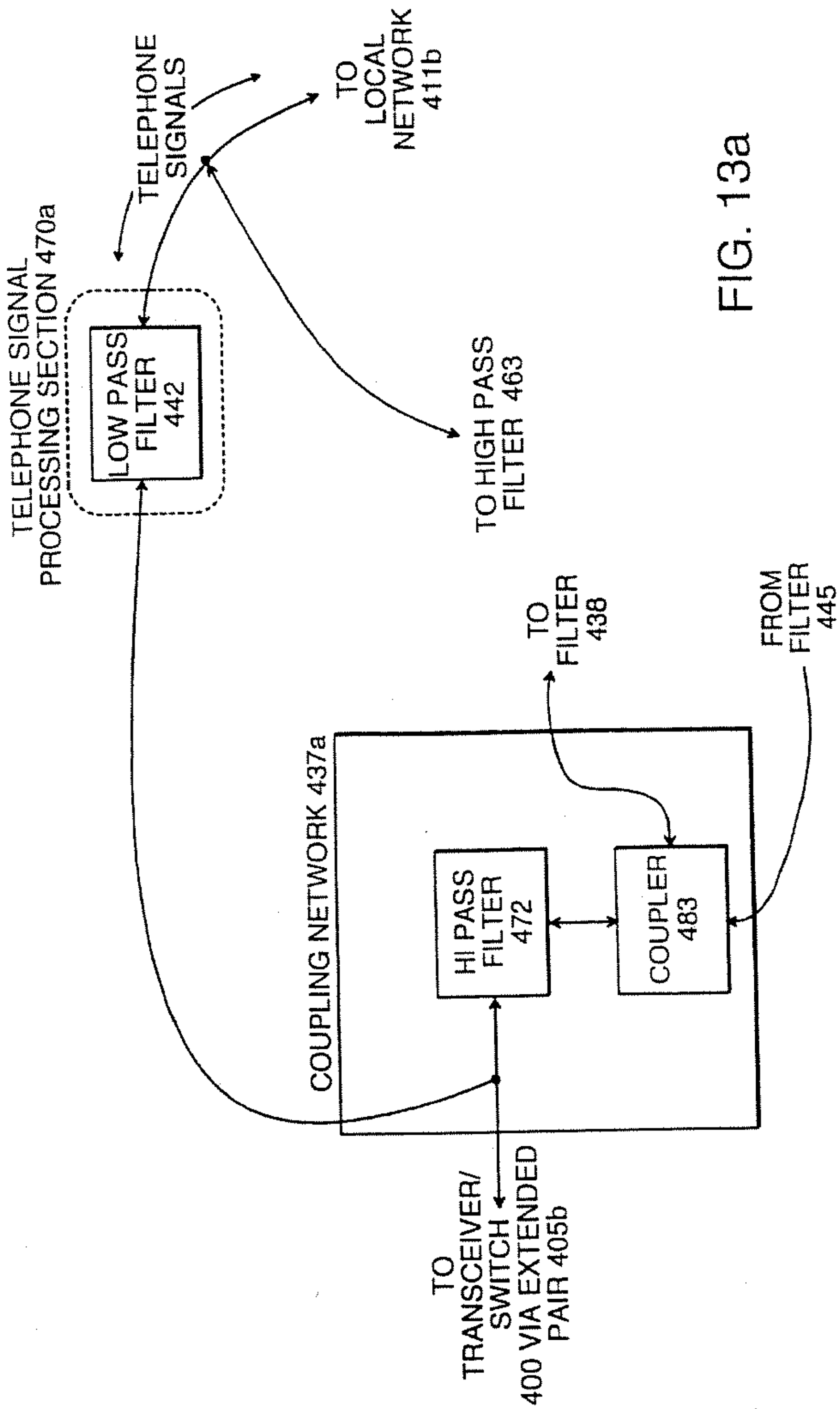

TELEPHONE SIGNALS
TO LOCAL NETWORK 411b
TELEPHONE SIGNAL PROCESSING SECTION 470a
LOW PASS FILTER 442
TO HIGH PASS FILTER 463
TO FILTER 438
FROM FILTER 445
COUPLING NETWORK 437a
HI PASS FILTER 472
COUPLER 483
TO TRANSCEIVER/ SWITCH 400 VIA EXTENDED PAIR 405b

FIG. 13a

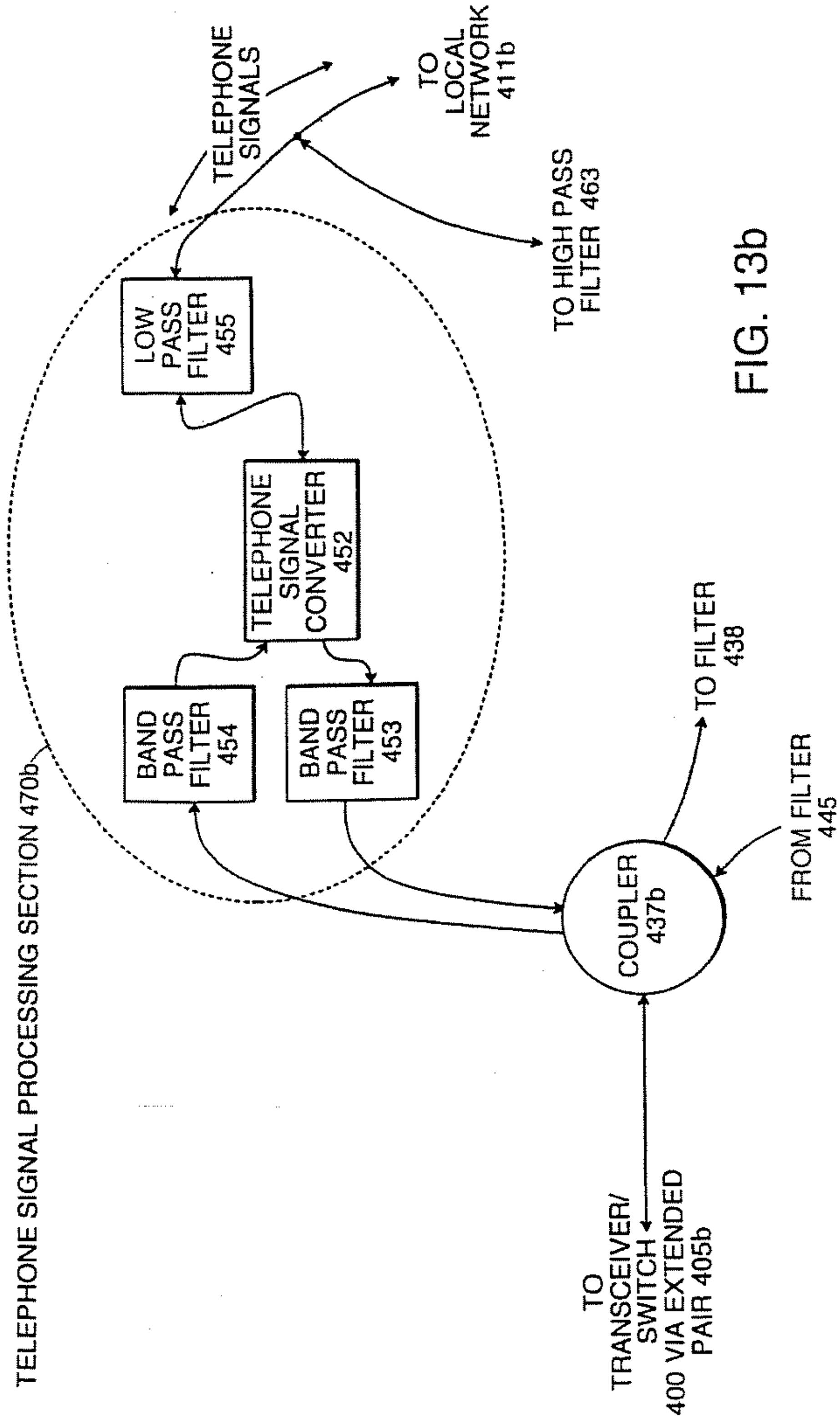

TELEPHONE SIGNALS
TO LOCAL NETWORK 411b
TO HIGH PASS FILTER 463
LOW PASS FILTER 455
TELEPHONE SIGNAL CONVERTER 452
BAND PASS FILTER 454
BAND PASS FILTER 453
TO FILTER 438
FROM FILTER 445
COUPLER 437b
TELEPHONE SIGNAL PROCESSING SECTION 470b
TO TRANSCEIVER/ SWITCH 400 VIA EXTENDED PAIR 405b

FIG. 13b

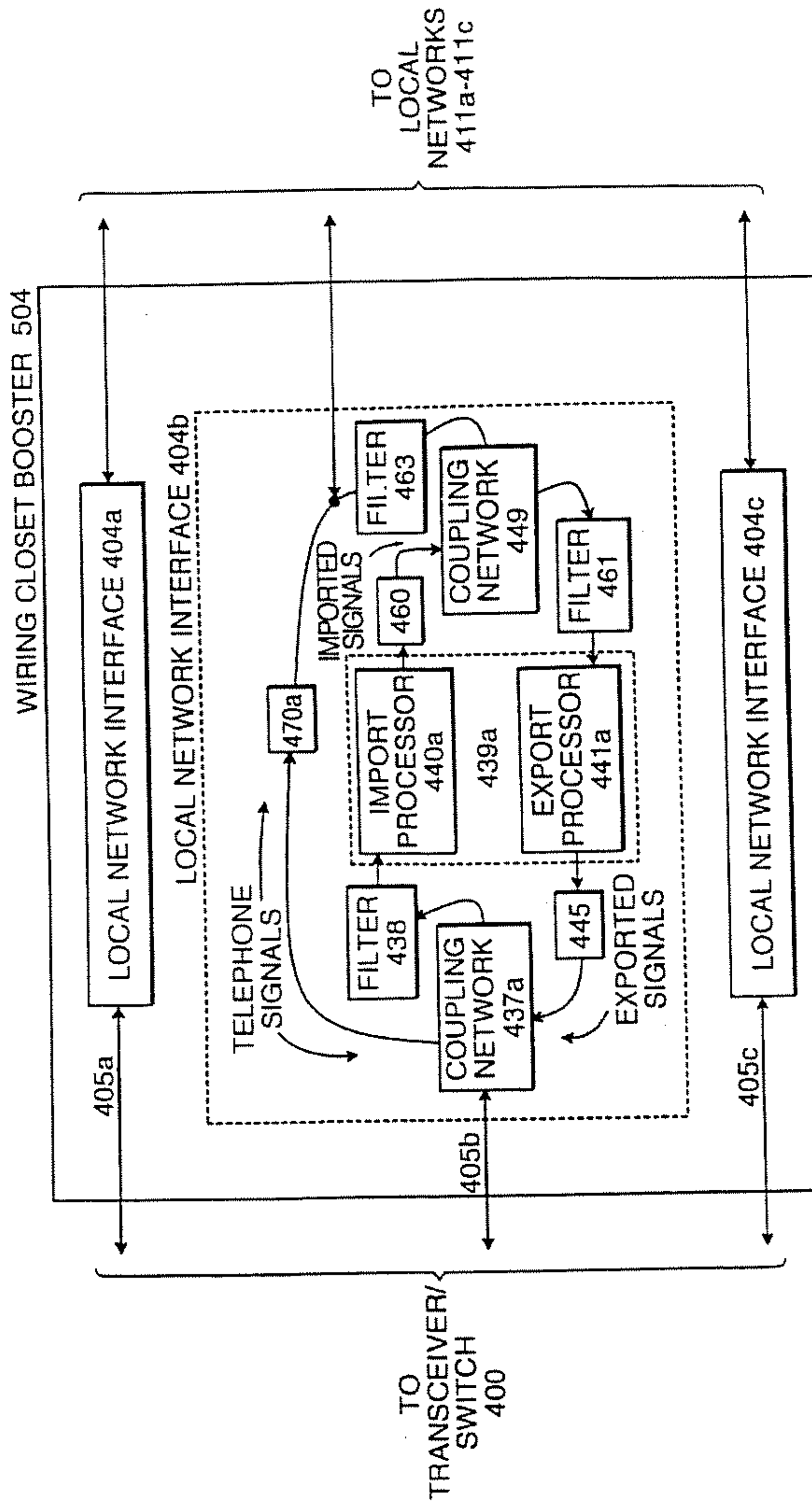

TO LOCAL NETWORKS 411a-411c
WIRING CLOSET BOOSTER 504
LOCAL NETWORK INTERFACE 404a
LOCAL NETWORK INTERFACE 404b
LOCAL NETWORK INTERFACE 404c
FILTER 463
COUPLING NETWORK 449
FILTER 461
IMPORTED SIGNALS
460
470a
IMPORT PROCESSOR 440a
439a
EXPORT PROCESSOR 441a
TELEPHONE SIGNALS
FILTER 438
445
EXPORTED SIGNALS
COUPLING NETWORK 437a
405a
405b
405c
TO TRANSCEIVER/ SWITCH 400

FIG. 14

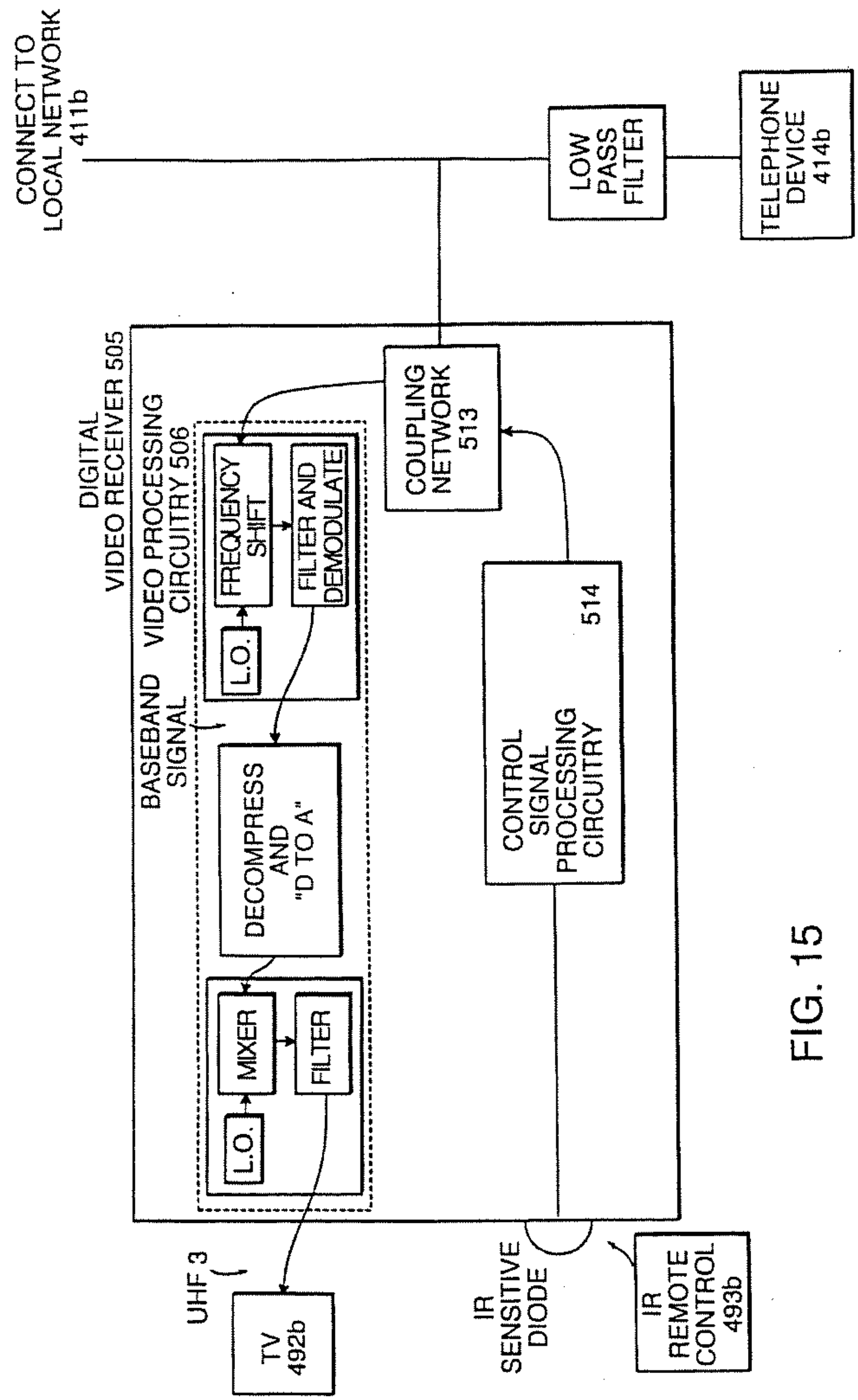

CONNECT TO LOCAL NETWORK 411b
LOW PASS FILTER
TELEPHONE DEVICE 414b
DIGITAL VIDEO RECEIVER 505
VIDEO PROCESSING CIRCUITRY 506
COUPLING NETWORK 513
FREQUENCY SHIFT
FILTER AND DEMODULATE
L.O.
BASEBAND SIGNAL
DECOMPRESS AND "D TO A"
CONTROL SIGNAL PROCESSING CIRCUITRY
514
MIXER
FILTER
L.O.
UHF 3
TV 492b
IR SENSITIVE DIODE
IR REMOTE CONTROL 493b

FIG. 15

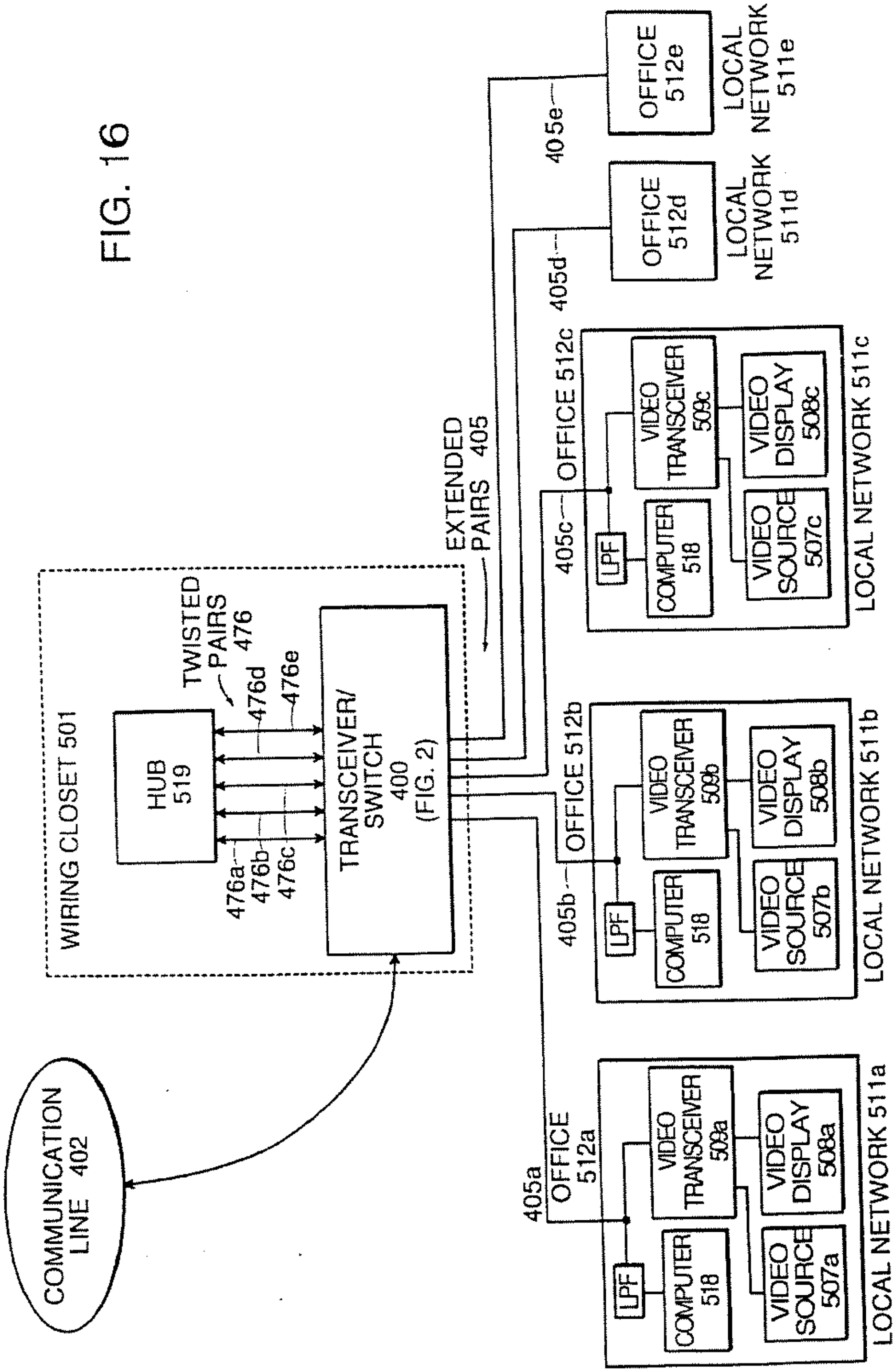

WIRING CLOSET 501
HUB 519
TWISTED PAIRS 476
476a
476b
476c
476d
476e
TRANSCEIVER/ SWITCH 400 (FIG. 2)
EXTENDED PAIRS 405
COMMUNICATION LINE 402
405a
405b
405c
405d
405e
OFFICE 512a
OFFICE 512b
OFFICE 512c
OFFICE 512d
OFFICE 512e
LPF
COMPUTER 518
VIDEO TRANSCEIVER 509a
VIDEO TRANSCEIVER 509b
VIDEO TRANSCEIVER 509c
VIDEO DISPLAY 508a
VIDEO DISPLAY 508b
VIDEO DISPLAY 508c
VIDEO SOURCE 507a
VIDEO SOURCE 507b
VIDEO SOURCE 507c
LOCAL NETWORK 511a
LOCAL NETWORK 511b
LOCAL NETWORK 511c
LOCAL NETWORK 511d
LOCAL NETWORK 511e

FIG. 16

DISTRIBUTED SPLITTER FOR DATA TRANSMISSION OVER TWISTED WIRE PAIRS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. Ser. No. 09/191,168, filed Nov. 13, 1998, which is a continuation of U.S. Ser. No. 08/814,837, filed on Mar. 11, 1997, which issued as U.S. Pat. No. 5,844,596 on Dec. 1, 1998, which is a continuation of U.S. Ser. No. 08/673,577, filed on Jul. 1, 1996, which is a continuation of U.S. Ser. No. 08/545,937, filed on Oct. 20, 1995, which is a continuation of 08/372,561, filed on Jan. 13, 1995, which is a continuation of U.S. Ser. No. 08/245,759, filed on May 18, 1994, which is a continuation of U.S. Ser. No. 08/115,930, filed on Aug. 31, 1993, which is a continuation of U.S. Ser. No. 07/802,738, filed on Dec. 5, 1991, which is a continuation of U.S. Ser. No. 07/688,864, filed on Apr. 19, 1991, which is a continuation-in-part of U.S. Ser. No. 07/379,751, filed on Jul. 14, 1989, which issued as U.S. Pat. No. 5,010,399 on Apr. 23, 1991.

INTRODUCTION

The present invention relates to a system for simultaneous two-way communication of video signals and other signals between multiple networks of telephone wiring whose twisted pairs converge together into a single bundle, wiring block, or other common point of access, and a high capacity communication line located at that point of access. Each network includes a set of interconnected, active telephone wires (i.e., a group of wires that create a conductive path for telephonic signals) internal to a house, an apartment unit, or a room in a commercial building. (Such wiring internal to houses, apartment units, or rooms in commercial buildings shall be referred to herein as "local networks.") In the case of houses, the point of common access can be a telephone pole. In the case of apartment buildings, the point of access can be the "wiring closets" found in those buildings. In the case of commercial buildings, the point of access can be the electronic PBX, or "private branch exchange" common to those types of buildings. The high capacity line can be a coaxial cable or an optical fiber. In addition to communication between each network and the high capacity line, communication from one network to another is also provided.

This invention is partly an outgrowth of technology presented in the parent application, and two other continuations-in-part thereof, respectively entitled "RF Broadcast System Utilizing Internal Telephone Lines" (hereinafter, the "first CIP application") and "Cable TV Distribution and Communication System Utilizing Internal Telephone Wiring" (hereinafter, the "second CIP application"). The first and second CIP applications were filed on the same day as this application. The parent application and the first and second CIP applications are incorporated herein by reference.

The communication systems disclosed in the parent and first and second CIP applications are designed to simultaneously transmit telephone signals and non-telephonic signals (such as cable television signals, other video signals, audio signals, data signals, and control signals) across the active telephone wiring internal to (i.e., locally within) residences and other structures. The present invention adds to these techniques, providing distribution of all of these signals to a local network of active telephone wiring (i.e. the wiring internal to a house, apartment unit, or a room in a commercial building) from a distribution device that connects to the trunk line of a public or private telephone network. That device is located where the telephone lines for multiple local networks converge to meet the public network trunk (or PBX, in the case of office buildings), enabling the distribution device to perform communication functions for many local networks at once, including communication between one local network and another. The distribution system works just as well when the point of convergence is the center of a computer communications network with a "star" topology, and the wires are the twisted pair wires connecting each individual computer to this center.

BACKGROUND OF THE INVENTION

The current method of providing cable TV signals to a house requires that a cable branch (typically a coaxial cable) connect from the main cable trunk to each subscriber. In addition, at the end of the subscriber branch, an additional segment of the coaxial cable must be installed for every extra TV "hookup" within the residence.

The challenge of providing cable TV to an apartment building is even more formidable. If coaxial cabling is not included at the time of construction, a coaxial cable leading through the entire building must be installed, and a branch must connect between each of the individual apartment units to a point on this cable. This is obviously an expensive procedure, even if easily accessible cabling conduits exist. Furthermore, each branch provides service at only one location within the unit it connects. Extra branches must be installed to provide cable TV service at other locations in the unit.

Providing a group of TV signals to various rooms in an office building currently requires a similar amount of coaxial cable installation. The demand for economical video distribution within office buildings is increasing, moreover, because of the increased popularity of video teleconferencing.

The method of distributing cable TV signals commonly used in the U.S. can be called a "one-way branched" system because signals transmitted at the head-end (i.e., at the root or entrance point to the network) spread across to each of the various subscribers by continually splitting into multiple downstream branches. Due to an increase in the popularity of video programming, however, demand for a new system has emerged. Under the new system, sometimes called "video on demand," a subscriber can request a specific program from a library of programs stored at a central location on, for example, video tapes. The signal from this program is subsequently sent to the subscriber from the "head end" of the system. No other viewers can receive the same signal unless they make a similar request.

One method for providing video on demand is to install a high-capacity fiber optic transmission line from the library through a series of residential or commercial neighborhoods. At each neighborhood, all signals targeted for the local residences or businesses (hereinafter, the term "residence" is used to mean both types of buildings unless otherwise stated) are encoded (i.e. scrambled) and then "handed off" at different channels onto the coaxial cable branch that feeds those residences. Thus, each neighborhood has its own individual headend at the point of handoff.

To prevent all residences from receiving each of the signals handed off to their neighborhood, a control signal is sent over the fiber optic transmission line that includes the "address" of a converter box in the house of the subscriber who requests a particular signal. This control signal provides

descrambling instructions that, because of the addressing, only the targeted converter box will recognize. Under this system, each subscriber receives all signals targeted for his or her neighborhood, but only the program (i.e., the specific video signal) actually requested by a subscriber becomes available to him or her in unscrambled form.

The concept of "video on demand" can be considered to be part of a broader communication concept. The broader concept is the widening of communication paths to the ordinary subscribers on the switched public communication network. This would enable subscribers to communicate video signals and other relatively wide bandwidth signals in the same way that they currently communicate voice signals.

The transmission medium that is best suited to provide wider communication paths is fiber optic cables. Indeed, many of the public telephone companies have converted most of their main communication trunks to fiber optics, and have upgraded their switching equipment to handle these signals and their attendant increase in data rates.

To bring the wider capacity to an individual site, however, requires one to install a new fiber optic branch from the main fiber optic trunk to each local network (i.e. a house, apartment unit, or a room in an office building), and to switch signals from the trunk onto the branches. Furthermore, conversion from light to electrical signals must take place at the point where the branch reaches the targeted residence. (Conversion is necessary because the communication devices currently found in typical residences and offices respond to electrical signals.) Finally, the electrical signals must be distributed through the house.

SUMMARY OF THE INVENTION

The invention described in the second CIP application eliminates the need for installation of multiple coaxial cable branches within a residence. Once a feed from the main cable trunk is brought to a house or apartment unit, the technology described in that application can transmit signals from that feed onto the internal active telephone wiring of the residence, using those wires to carry the signals to the individual televisions. Thus, only the coaxial cable which leads from the main cable trunk to the residence is necessary.

One general concept that this invention provides is the use of active telephone wiring (i.e., wiring that is also used for its normal purpose to carry telephone signals) as the transmission line leading from a main cable trunk (which is coaxial cable or fiber optics) to the individual subscribers. This significantly reduces the complexity and expense normally associated with cable TV wiring, above the reduction described in the second CIP application. A major advantage of this wiring over coaxial cable is that nearly every residence (such as an individual house or an apartment unit in an apartment building) has one or more phone lines, each including at least one twisted pair (e.g., the red-green pair; typically, a second twisted pair of black-yellow wires is also provided) leading to it from the telephone company trunk line. A second advantage is that signals applied to the telephone line are available at every telephone jack, rather than at a single coaxial outlet.

Thus, a general aspect of this invention is a system that provides video signal communication between a source of the video signal and a plurality of units that include destinations of the video signal and that includes an interface coupled to the source and to telephone lines, each of which serves at least one of the units and carries voice signals to and from one or more telephones coupled to the telephone line at said unit. The interface receives the video signal from the source, and transmits the received video signal onto at least one of the telephone lines in a selected frequency range that is different from frequencies at which the voice signals are carried on that telephone line. This causes the video signal to be coupled to a receiver which is connected to the telephone line at the unit served by that line and is adapted to recover the video signal from the telephone line and apply it to one or more of the destinations at the unit.

Preferred embodiments include the following features.

The source is a cable (e.g., electrical or fibre optic) that is linked to the interface and that carries a plurality of video signals. The destinations are, e.g., televisions. The units can be residences (such as individual houses or apartments in an apartment building) or offices in an office building. Hereinafter, the term "residence" will be used for all such units.

The interface is adapted to select one or more of the video signals in response to control information from a user or users of televisions at any residence and transmit the selected video signal or signals onto the telephone line that serves that residence for recovery and application to one or more televisions in the residence. If multiple video signals are selected for a given residence, the interface transmit the video signals onto the telephone line that serves that residence at different frequencies within the selected frequency range. This prevents the selected video signals from interfering with each other.

The interface can select the same video signal for multiple residences and transmit the video signal onto the plurality of telephone lines that serve those residences. Further, the same video signal can be sent over the telephone lines at the same or different frequencies.

At least one of the residences includes an internal telephone link to which its receiver and at least one telephone is connected. The internal telephone link is connected to the telephone line that serves that residence, either directly or via a local interface. The local interface amplifies video signals received over the telephone line and couples them onto the internal telephone link. This helps compensate for attenuation that typically occurs during transmission to the local interface, thereby increasing the quality of the video signals recovered by the receiver.

At least one of the residences includes a source (e.g., a video camera) that applies a second video signal that applies said second video signal onto the internal telephone link in a second selected frequency range that is different from both the frequency range selected by the interface and the frequencies at which the voice signals are carried on the telephone link. The local interface amplifies the second video signal and couples it onto the telephone line that serves the residence to cause the second video signal to be coupled to the interface. The interface, in turn, transmits the second video signal to the source.

The interface is coupled between the telephone lines and corresponding public telephone lines (which carry voice signals at voiceband frequencies) that serve the residences. In one embodiment, the interface couples the voice signals between each public telephone line and each telephone line at voiceband frequencies, and the selected frequency range exceeds the voiceband frequencies.

In another embodiment, the interface converts the voice signals on the public telephone lines to a frequency range above voiceband frequencies before coupling the voice signals onto the telephone lines for transmission to the residences. In this case, at least a portion of the selected frequency range for the video signals includes voiceband